GEOLOGY OF WABASH COUNTY.

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GENERAL AND DESCRIPTIVE.

Wabash County is bounded on the north by Kosciusko and Whitley; on the east by Whitley and Huntington; on the south by Grant and Miami, and on the west by Grant and Fulton Counties. It is twenty-seven miles long and sixteen miles wide, except three by two miles off the northeast corner of the county which forms a part of Whitley County. It contains 432 sections of land, or about 426 square miles, equal to 272,640 acres.

The county was organized by an act of the Legislature approved January 22, 1835, which took effect on the first day of the following March. Since its organization the county has been divided into seven townships: Pleasant, Pawpaw, Noble and Waltz on the west side of the county, and Chester, Lagro and Liberty on the east side. Pawpaw is the smallest township in the county, and contains forty sections; Lagro is the largest with eighty-four square miles, and is said to have a greater area than any other township in the State by one-half a section; as a school corporation it has twenty-nine school houses, and its township trustee employs thirty-four teachers annually. Noble township is the next in size, with nearly sixty-eight square miles of territory.

Wabash, the capital of the county, is seventy-two miles north and seventeen miles east, or about eighty-eight miles northeast of Indianapolis. It is beautifully located on the north bank of the Wabash River at the site of the old Indian treaty grounds, and was platted in the spring of 1834 by Col. H. Hanna and David Burr. The first houses built in the new town were erected on the river terrace, and all the early stores were confined to the same neighborhood. The completion of the Wabash and Erie Canal made it an important commercial centre, and gave great impetus to its growth that has been steady and vigorous. At this time it is a city with all the conveniences of modern city life. The lower or south part of the city is occupied by large manufacturing establishments and stores. Generally the residences are confined to the plateau back

of Hill Street, which is four squares north of the canal. It has broad, well paved streets that are set with handsome shade trees, and shut in by fine residences. The court house is a beautiful structure, surrounded by well-kept grounds, that reflect the taste and culture of the people.

North Manchester is an important town, located on the level plain just north of Eel River. It is noted for its mills, factories and business energy, and has a bright prospect for the future.

North Manchester and Roann are incorporated towns, and La Fontaine, Liberty Mills and Somerset have sufficient postal business to give them money order privileges. Besides these there are twenty other postoffices in the county, all of them thriving towns and villages, and centers of an active country trade.

The Wabash Railway, in crossing the county, follows within one mile the course of the north bank of the Wabash River from east to south of west. The Eel River division of the Wabash System enters the county from the west, near the middle of Pawpaw Township, and runs northeast through Pawpaw, Pleasant and Chester townships. The Chicago & Erie Railroad crosses the county in a northwest course from near the southeast corner of Chester Township and out through the west part of Pleasant. The Cincinnati, Wabash & Michigan Division of the Big Four System enters the county near the middle of Liberty Township, and in a general way runs west of north until it reaches Wabash. From there it passes north near the line dividing Noble from Lagro and Chester from Pleasant and Pawpaw townships. With the exception of a small part of the southwest corner of Waltz Township, none of the citizens of the county are more than six miles from a railroad station, and those living north of the Wabash River are more than well supplied with marketing facilities. The railroad stations are Belden, Lagro, Wabash and Keller's (Rich Valley P. O.), on the main line of the Wabash; Roann, South Laketon, North Manchester and Liberty Mills, on the Eel River Division; Servia, Bolivar, Newton, Laketon and Disko, on the Chicago & Erie, and Lafontaine, Treaty, Wabash, Urbana, Bolivar, North Manchester and Rose Hill on the Cincinnati, Wabash & Michigan.

The principal pikes are the Wabash and North Manchester, Wabash and Lafontaine, Wabash and Dora, Wabash and Mt. Vernon, Mill Creek, Lagro and North Manchester, Lagro and Township Line, the New Holland, the Jesse D. Scott Pike, and many others which have been built very recently. The absence of that old nuisance, the toll-house and its well-sweep, is a mark of progress that no one should more fully appreciate than the farmer who, heretofore, has been commanded to stand and deliver before he could pass. Good roads are essential to good markets, and no people appreciate this fact more than the citizens of Wabash County. The common roads are in good repair, and only need that the present practice of annually adding a few more miles of gravel shall be

continued to make them equal to pikes. A conspicuous effect of the enforcement of the law against permitting stock to run at large is noticeable in the increased growth of bluegrass on the roadsides, which is killing off the common weeds that are so unsightly on many highways.

Schools and churches are numerous, and in educational matters the county has long stood in the front rank. All of the towns, and nearly all of the villages, have large, two-story brick buildings in which graded schools are taught, requiring the services of from three to seven teachers for eight or more months each year.

The earliest and latest written accounts of the Indian tribes of Indiana are connected with the history of the Wabash Valley, and it seems proper to notice the impress they have made on the geography of the county. This is especially seen in the regular boundaries of the farms on the Wabash and Mississinewa Rivers where the Indians were allotted reservations which follow the meanderings of the streams on one side and cut the section lines at an angle on the other. Lagro and La Fontaine are names of towns given in honor of Indian chiefs. Treaty and Treaty Creek commemorate historical events of interest to the whole State. The idea of admitting the wild Indians of the west to White's Manual Labor Institute has its origin in the presence of a few of their partially civilized brethren, survivors of once powerful tribes, located on the banks of the Mississinewa River. This institution owes its existence to the benevolence of Josiah White, of Philadelphia, Pa., a member of the Society of Friends, who left a sum of money to establish manual labor schools in Indiana and Iowa. With a part of this money a section of land on Treaty Creek, four miles southeast of Wabash, was purchased in 1852 of Washingomasha, a native Indian. On this purchase handsome brick buildings have been erected, surrounded by beautiful groves and driveways. The splendid farm connected with the Institute is one of great fertility and is kept in a high state of cultivation. It is at least poetic justice to an oppressed race that this school has been opened to the education of the Indian, where he is taught the arts and sciences, together with practical farming.

TOPOGRAPHY.

The lowest railroad elevation in the north part of the county, 666 feet above water, is at Keller's Station (Rich Valley P. O.), and the highest, 843 feet, is at the point where the Chicago & Erie Railway crosses the boundary line between Wabash and Huntington Counties. The altitude of the highest table land between the Wabash and Eel Rivers, south of North Manchester, is stated to be 824 feet, which is the same as that of New Harrisburg. Thirteen railroad elevations on the lines north of the Wabash River give 769 feet as the average height of the land; but as this average is estimated mainly from points on the roads that follows the

river valleys, it is not so high as an average would be made from the Chicago & Erie Railway. It is probable that the average altitude of the high lands on the divides between the rivers that cross the county will at least reach 800 feet. It is very much regretted that no report of the elevations on the line of the Cincinnati, Wabash & Michigan Railroad could be secured so as to give an idea of the topography south of Wabash. The only data available bearing on the subject are derived from gas well borings made in the vicinity of La Fontaine. These borings are reported in three wells to have passed through 300, 180 and 167 feet respectively of clay, sand and gravel before striking stone. Rejecting the first measurement as anomalous and adding the mean of the other two wells, 174 feet, to the altitude of the surface of the country rock in the court house square, 730 feet, gives an elevation of 904 feet* for that part of the county, an excess of 61 feet above the highest point given north of the Wabash River. Low water in the river at Belden is reported at 680 feet above high tide in the Gulf of Mexico; the mouth of the Salamonie River is 667 feet, and the surface of the stream at Wabash is 638 feet, a fall of 42 feet within 11 miles. The difference between the level of the grade, 701 feet, and the level on the boundary line where the Chicago & Erie Railway crosses, 843 feet, shows a rise of 138 feet within 5 miles. The court house square, 730 feet, is 92 feet above the surface of the Wabash River, and 102 feet below the table lands between the county seat and North Manchester.

The general surface of the county is level or rolling. The so-called hills seen along the rivers, creeks and ravines are the bluffs formed by the valleys and channels of the country. There are no hills in the county except a few isolated gravel mounds in the northwest portion of Pleasant Township. The creek valleys and beds in the uplands, which constitute a vast majority of the surface of the county, are slight depressions in the soil, clay and gravel. The river valley bluffs at Dora are forty feet, at Lagro fifty feet, and at Wabash City from sixty to seventy feet high. On Eel River they are from twenty-five to thirty feet high, and on the Missisinewa they average sixty feet. All of the creek valleys and many of the ravines in their lower courses cut down to a level with the river terraces. These cross-valleys diversify the outline of the river bluffs and cause the adjacent upland surface to be broken. The clay-covered bluffs gradually sweep down to the valley meadows and present a rounded appearance; the gravel bluffs are more abrupt in outline and frequently precipitous; those built up of exposed stone are often perpendicular cliffs. Frequently two or more of these types are merged together and modify the form of the elevation. As a rule, clay-covered bluffs are common to streams north of the Wabash River and to the creeks in the south part of the county. Gravel banks are seen in greatest force on

*This estimate is ten feet higher than the altitude given by the railroad.

Salamonie and Mississinewa Rivers, and the rocky cliffs are confined to the Wabash, Mississinewa and Salamonie River Valleys.

The surface drainage of the county finally reaches the Wabash River. The general direction of the course of the rivers is to the west and that of the creeks to the southwest or the northwest. An exception to the rule as applied to the creeks is seen in the northwest corner of the county, where the flow is to the south and southeast. Eel River and the Mississinewa are crooked streams, with rather sluggish currents, and the water of the former more or less muddy. The direction of the water shed between the Wabash and Eel Rivers is well marked on a good map of the county, and runs nearly parallel with those streams from east to west. The divide between the creeks flowing into the Wabash and those flowing into the Mississinewa River runs nearly due west through Liberty and Waltz Townships.

Round, Long, Mud, Bull, Bear, Lukins, Flora's, Flat and Twin Lakes are small bodies of water covering from twenty-five to eighty acres, and are confined to the northwest part of the county. They are fed by springs, and once were well stocked with fish. It is in the vicinity of these lakes that the "oak openings" occur. In the early history of the county the undergrowth common to the timber lands was replaced in the "openings" by a rank growth of grass. This grass was burned annually by the Indians, to the destruction of the young timber, but not to the injury of the larger trees. Near the "openings" were treeless swamps that have been reclaimed by drainage and are now known as among the most fertile lands in the State.

PALÆZOIC GEOLOGY.

The following connected section is intended to show the average thickness of the various formations exposed in the county and their relations to each other in successive periods of time:

GENERAL SECTION OF WABASH COUNTY.

CENOZOIC TIME.

QUARTERMARY AGE.

RECENT PERIOD.

Recent, Alluvial and Lacustral Epochs.

No. 1. Surface soil, river terrace and black soil . . . . . 4 feet.

DRIFT PERIOD.

Glacial Epoch.

No. 2. Clay, gravel, sand, blue and yellow clays and modified drift . . 100 feet.

PALÆZOIC TIME.

UPPER SILURIAN AGE.

NIAGARA PERIOD.

Niagara Epoch.

No. 3.	Even bedded, fossiliferous, buff fag and quarry limestone . . .	17 feet
No. 4.	Irregular, nonstratified, gray limestone, from 15 to 60 feet thick, and locally known as picket rock	"
No. 5.	Laminated, generally even bedded, buff shale	15 "
No. 6.	Upper portion shaley or amorphous cement rock, bedding compound; lower portion evenly bedded hydraulic limestone; fossils rare	135 "
	Total	267 feet.

The term "quarry stone," wherever it occurs in this report is used to include No. 3 of the general section. No. 4 is not carried into the column of average thickness for the reason that it seems to represent a group of rocks that are the result of changes which have taken place since the original strata were deposited. Frequently its materials are the modified strata of Nos. 3 and 4, and the upper portion of No. 6. It always includes a portion of No. 3 in its structure. This formation is locally known at Wabash City as "picket rock," and as the term is a convenient one, it is used to distinguish the stone of this remarkable group from all others, and for the further reason that it does not carry with it any preconceived theory as to its origin. "Laminated shale" is used as the equivalent of No. 5, and "cement rock" to embrace the shaley and amorphous upper portion of No. 6. The use of the term "hydraulic limestone" is restricted to the lower stratified beds of No. 6.

With the exception of the quarry stone, which is distinct in structure from the contiguous and underlying shale, the lines of separation and transition from one formation to another are not well marked. In passing downward No. 4 gradually changes from thin laminated shale to blue cement shale. The whole of No. 6, whether massive or shaley, horizontal or inclined, evenly or compoundly bedded is more or less hydraulic. It is distinguished from the laminated shale by its hydraulic qualities, and for the same reason is described as a distinct group.

The local dip is so extremely variable that no exposures are to be found on which conclusions as to the direction of the general dip can be based. The only data available is derived from measurements made in making the survey for the Wabash and Erie Canal. By this survey it was found that the court house square at Huntington was 741 feet, and the court house square at Wabash 730 feet above the ocean, a difference of only 11 feet. As both court houses are built on the same geological horizon, the top of the quarry stone, the dip west from Huntington to Wabash is

found to be less thon eight inches to the mile. More recent surveys made in running the levels for the Wabash Railroad show that the Wabash station is eight feet higher than the station at Huntington, but this apparent contradiction of the figures derived from the Wabash and Erie Canal surveys is because they are not built on the same geological level, the station at Huntington being below the top of the Niagara group quarry stone. Passing down the Salamonic River the top of the hydraulic limestone beds, near the mouth, rise to a higher level above the channel than they do at Dora; but as this rise may be wholly due to the increased depth of the channel, it is not possible to determine the degree of dip without running levels.

LIST OF FOSSILS FOUND IN WABASH COUNTY

CŒLENTERATA.

Anthrozoa.

Zaphrentis celator, Hall.
Zaphrentis sp (?).
Favosites niagarensis, Hall.
Halysites catenulatus, Linn.
Dictyonema sp (?).

ECHINODERMATA.

Crinoidea.

Pisocrinus gemmiformis, S. A. Miller.
Pisocrinus campana, S. A. Miller.
Pisocrinus benedicti, S. A. Miller.
Pisocrinus gorbyi, S. A. Miller.
Pisocrinus n. sp.

MOLLUSCOIDA.

Bryozoa.

Lichenalia concentrica, Hall.
Ichthyorachus, n. sp.
Sagenella elegans, Hall.
Paleschara maculta, Hall.
Trematopora varia, Hall.
Trematopora granulifera, Hall.
Tenestella parvulipora, Hall.

MOLLUSCA.

Brachiopoda.

Orthis benedicti, S. A. Miller.
Orthis elegantula, Dalman.
Orthis biloba, Linn.
Atrypa reticularis, Linn.
Meristina nitida, Hall.
Sperifera crispa, Hisinger.
Strophomena rhomboidalis, Wilckins.

Cephalopoda.

Orthoceras crebescens, Hall.
Orthoceras unionense, Worthen.
Orthoceras regidum, Hall.
Orthoceras columnare, Hall.
Orthoceras strix, Hall.
Orthoceras obstrictum, Newell.
Gomphoceras wabashensis, Newell.
Phragmoceras linearis, Newell.
Phragmoceras augustum, Newell.
Phragmoceras parvuni, H. & W.
Phragmoceras nestor, Hall.
Phragmoceras projectum, Newell.
Hexamoceras cacobiformis, Newell.
Lituites bickmoreanus, Whitfield.
Lituites graftonensis, M. & W.
Lituites multicostatus, Whitfield.
Lituites marshi, Hall.
Trochoceras desplainense, McChesney.

LAMELLIBRANCHIATA.

Ambonychia acutirostra. Hall.

CRUSTACEA.

Trilobita.

Calymene niagarensis, Hall.

All the fossils of the foregoing list were found in the quarry stone. The laminated shale and hydraulic limestone strata, so far as examined, are devoid of organic remains. The cement shale, in the vicinity of Lagro, gives promise of yielding fine specimens of trilobites. At Hanging Rock many fragments of *Calymene niagarensis* and other genera were found

in the blue, amorphous stone that had fallen from the overhanging rock. One specimen each of *Orthoceras strix*, a *Lituites*, and the mould of a *Pleurotomaria*, were found in the cement shale of Lagro Creek, two hundred yards below the Sheets stone quarry. The quarries at South Wabash, Wabash, Lagro and on the Missisinewa River are all good fields in which to collect fossils. There is said to be a three-inch stratum of stone in the quarry east of Wabash and near the railroad tracks that is a mass of trilobites. Making due allowance for the exaggerations one hears about such things, from those not familiar with collecting, there remains no doubt but fine specimens are to be found in that vicinity. Good ones were seen on the face of the flagging in the Lambert quarry at South Wabash. Of course it is not to be presumed that the annexed list is complete; it embraces only such species as were found in the hurry of other work. This county is a good one in which to collect, and promises to become especially noted for its fine specimens of cephalopodæ. A cast of a *Pentamerus* was seen at Rockyway Falls, and a single specimen of *Pisocrinus* was found in the picket rocks near the mouth of Charley Creek. Other forms not identified were seen in the equivalent stone at Hanging Rock.

The Niagara Group stone of this county, like that of Southeastern Indiana, is remarkable for the size and abundance of the chambered shells found in it, and the scarcity of brachiopodæ. The various species of *Phragmoceras*, *Gomphoceras* and *Litiutes* named in the list seem to be restricted to the northern part, and the species of *Gyroceras* to the southern part of the State. *Orthoceras strix* has never been found on Clifty Creek, but is quite common in Wabash County, where it grew to a great size. A fine specimen, slightly curved, was seen near the Watson Briggs Ravine, that measured twenty inches long. Other curved forms were seen at Wabash. *Orthoceras annulatum*, a species common at St. Paul and Hartsville, seems not to occur here.

GENERAL GEOLOGY.

NIAGARA GROUP.

Nowhere in the State can the stratigraphical geology of the Niagara Group be so thoroughly studied as in Wabash County. All the phenomena peculiar to the stratification of the county are found at other places on the Wabash River and elsewhere, but, interesting and remarkable as they are, none of them shows so well the vertical extent and the relation of the different members of the group. The Hanging Rock exposure has a vertical range of seventy-eight feet and includes all the divisions of the general section. Many other exposures show sixty feet of stone.

The problems to be discussed in stratigraphy grow out of the local variations in the dip and the compound bedding of the strata. This is made apparent to any one who will examine the outcrops in Wabash and vicinity. At the east end of the Cincinnati, Wabash & Michigan Railway bridge over the Wabash River is seen a large cone-shaped mass of stone that at first glance seems to be the result of an upheaval. This impression is confirmed by the high angle dip of the exposed side. Further examination shows fifteen or more feet of thin laminated shale, approximately horizontal, resting against the sides of the cone. East of the city, near where the Wabash Railroad crosses the Cincinnati, Wabash & Michigan Railway, the laminated shale is found to be covered with even-bedded quarry stone. Here the quarry stone and the underlying laminated shale are stratified in the same plane and apparently lying in a different plane unconformable to that of the picket rock. The question at once arises: Were all these formations the result of sedimentary deposits which took place in regular geological sequence? Are the picket rock cones the result of changes that have taken place since the close of the Niagara period, and was the material of which they are composed once evenly stratified and identical in structure with the surrounding quarry stone and shale? If so, what have been the conditions and what the physical and chemical forces which have changed the quarry stone and soft laminated shale into hard, amorphous limestone? Are the picket rock cones the result of an upheaval? Are the lines of separation on which the dip is taken stratification planes, or are they a peculiar form of jointed structure and cleavage? It is the purpose of the portion of the report devoted to general geology to make such answers to these questions as seem to be probably correct, and to describe the structure and geographical distribution of each division of the general section.

The outcroping stone seen in the county belongs to the hyraulic limestone division of the general section. It is the stratified stone quarried in the vicinity of New Holland on Rush Creek, and appears in heavy beds at Dora in the banks of the Salamonie River. As a gray stratified stone it is common in the vicinity of Lagro. It is the bed-rock of the lower course of Treaty and Helm's Creeks, in the lower bluff banks of the Wabash River at Rich Valley, and in the banks of the Missisinewa. It will be found as the bed-rock over which the waters of the Mississinewa, Wabash and Salamonie Rivers flow throughout the county. Overlaying the hydraulic limestone, and having the same geographical range, comes the cement shale and amorphous cement rock, except where eroded away in the river valleys. The irregularly bedded, unstratified amorphous rock and cement shale are found in greatest force in the vicinity of Lagro, where forty-six feet of it are exposed in the higher bluff banks of Lagro Creek. That these formations extend

below the level of the bottom of the Wabash River, was shown by the boring made in sinking the Lagro public well, on Washington Street, where the cement shale and hydraulic limestone were penetrated to the depth of sixty-eight feet. The depth of the well added to the forty-six feet of stone exposed in the bluffs above the level of Washington Street gives a total thickness of one hundred and fourteen feet. It has been estimated from data derived from gas well borings made in the county that the total thickness of the shale and stone having hydraulic properties may reach two hundred and fifty feet.

The hydraulic limestone, wherever seen, was found to be uniformly stratified with clay or shale partings, and without more than a slight dip of one or two degrees. At the north end, and below the Lagro wagon bridge over the Wabash River, there is an exposure of the lower beds that beautifully show the stratification, level as a house floor, and cut by two vertical seams, ten feet apart, that run exactly parallel for more than one hundred feet. Above the lower dam across the Salamonie River, by taking a boat, the exposure can be easily traced for nearly one mile with but a slight dip to the northwest. The color is generally blue, weathering to gray. Where the percentage of alumina is large it gives the stone a laminated structure that is shown in some of the blocks used in building the locks on the old Wabash and Erie Canal. In the quarry a short distance above Hanging Rock the argillaceous constituent is so much increased as to cause some of the strata to crumble to dust and thin laminated fragments; the lower beds, however, are massive and show little tendency to change. The fracture is generally conchoidal, but is not so well marked as in typical specimens of the amorphous cement rock, and breaks without visible evidence of crystalization. Typical specimens of hydraulic limestone are found in the New Holland quarries, at the old Wabash and Erie Canal quarry on the west bank of the Salamonie River, in the lower beds of the Somerset quarries, and near the mouth of Treaty Creek, of the amorphous cement rock in the quarry of the Lagro Cement and Manufacturing Co., and at the mouth of Helm's Creek.

SECTION OF THE QUARRY OF THE LAGRO CEMENT AND MANUFACTURING CO.

West Bank of Lagro Creek, Near Town of Lagro.

Soil	1 ft. 6 in.
Quarry limestone, flag	2 ft. 0 in.
Blue amorphous cement rock to the creek bottom	47 ft. 0 in.
Total	50 ft. 6 in.

A short distance up the creek from the cement quarry the following measurements were made:

SECTION.

West Side of Lagro Creek.

Soil and covered slope	10 ft.
Gray stratified quarry stone, flag	6 ft.
Amorphous cement rock and cement shale to the bottom of the ravine	35 ft.
Total	51 ft.

The amorphous cement rock of these sections is too massive to be called a shale. It also lacks the laminated structure of most shales. But in composition it is nearly identical with that of the cement shale, the term generally used to designate beds of this geological age.

Strictly speaking, the amorphous cement rock and cement shale are unstratified where the sections were made, and the same is true of the whole exposure along the banks of Lagro Creek. The face of the outcrop has lines of irregular bedding, which careful examinations show are due to changes in the lithological character of the stone, and not to clay or shale partings. Frequently the vertical section of a lenticular or triangular mass of stone, as it rests in place in the exposure, is seen to be surrounded, or bedded, in one or more thin crusts of stone that are broken into short fragments. These broken fragments, following the lines of bedding, indicate the planes of the so-called stratification, and doubtless show what, under other conditions of deposition, would have resulted in either a shale or clay parting. It is not all the planes of separation which show this tendency to stratification, many of them are true seams, or fracture lines, through the homogeneous mass of stone. This imperfect stratification forms the transition type of bedding between the horizontal strata of the hydraulic limestone and the cleavage structure of the picket rocks. At the cement quarry are lenticular masses five feet thick in the middle, which thin to a feather edge within thirty-five feet or less, and angular or wedged-shaped pieces that rapidly reverse the dip. The dip measured on the different lines of separation varies, within a few feet, from horizontal to an angle of thirty degrees. The upper part of the cement shale on Lagro Creek is very much broken by vertical and cross seams into irregularly shaped, angular pieces, varying from a few inches to as many feet in diameter. In the lower beds the seams are nearly vertical. At the cement quarry is a closed seam that reaches from the top to the bottom of the bluff, and can be readily traced across the bed of the creek. Where the adjacent stone has been removed from one side of the seam, in quarrying, it leaves the other side exposed with a face as smooth as polished marble. No vertical seams filled with earth were anywhere seen in the hydraulic limestone or cement shale; dirt seams are limited to the quarry stone. The Lagro Creek stone does not show appreciable change in physical appearance except in the top members of the exposure, which have a lighter color on the surface that is due to weathering.

SECTION AT HANGING ROCK.

South Bank of the Wabash River Near Lagro.

Massive, unstratified, fossiliferous limestone, equivalent of the picket rock	35 feet.
Thin bedded limestone, alternating with shale, lower strata thicker, with obscure fracture lines of separation	30 feet.
Amorphous cement rock	4 feet.
Even-bedded hydraulic limestone, with thin clay or shale partings, stratification approximately horizontal	5 feet.
Slope to water's edge	4 feet.
Total	78 feet.

Hanging Rock is one of two isolated, cone-shaped hills that stand in close proximity on a north and south line. The river-bottom highway passes between them, over a slight rise in the road. The base of the larger hill, Hanging Rock, covers about half an acre. The river front is precipitous and towers more than eighty feet above extreme low water. Standing on its isolated top, a magnificent view is presented to the eye of the Wabash River as it sweeps in gentle curves down the valley. To the north and east one sees dimly outlined the ancient bed where long years ago it ran, unruffled by the devices of civilization, in its course to the sea. Below can be traced its junction with the Salamonie. The beholder wonders, as he gazes over the broad valley with its high bluffs, what were the forces of nature, which have not only carried away the clay, sand and gravel of the Drift Period, but have by long erosive action removed miles of stone that once came above a level with the top of Hanging Rock. It is not alone the wonderful and picturesque scenery of the Quarternary Age that should invite attention. Here, better than anywhere else in the county, can the secrets of a much older world be read.

The upper member of the section has the same lithological characters as typical picket rock from the Wabash Cone. Below is seen beautiful examples of compound bedding, and under all evenly stratified limestone that does not show the slightest evidence of having been disturbed since its material fell as sediment on the bottom of the ocean. The upper thirty-five feet is without stratification or cleavage structure, but is divided into two nearly equal masses by a line of separation that has a slight dip to the southwest. The irregularly-bedded limestone is in strata estimated at four inches thick, alternating with thinner layers of shale. The edges of the limestone project beyond the more friable shale and show quite a curve, as if the strata had been bent upward at the northeast end, or it had been deposited in a trough. At the northeast angle of the river front of the outcrop a bed of stone composed of thin strata five feet thick was measured, which in twenty feet diminished to one foot, and another that diminished from four feet to two feet, both beds thinning in the same

direction. Other measurements were made in which the layers became thinner in the opposite direction; and it is by this system of alternating dip that the strata pass through the compound bedding from a horizontal plane below to a nearly level surface above. The dip varies from twenty degrees to five degrees. In physical appearance and fossils these limestone beds are the equivalent of the quarry stone of the general section, and occupy the same geological horizon. Below the quarry stone beds the physical characters of the strata change, without showing the intervening laminated shale of the Wabash quarries, to the cement rock of Lagro Creek. The stratification changes to obscure lines of separation that have the appearance of being fracture seams. In this portion of the section one stratum within a distance of twelve feet eight inches thins from twenty-one inches to nothing, and the stratum above it, measuring nine inches in the middle, vanishes to a point each way within eighteen feet. Under the irregularly-bedded shale is four feet of dark blue, amorphous cement rock. The external surface of this stratum has been polished by high water until it presents a very striking appearance, and has been freely used by visitors as a register on which to carve their names or initials and the date of their visit. The hydraulic limestone strata are approximately level, and as the equivalent beds, a short distance above and below on the Wabash River—in fact, wherever exposed—are without measurable dip, the inference is that this condition is not peculiar to the section. Thin clay or shaley partings between the layers indicate conclusively that they are truly stratified and of sedimentary origin. Closed seams that are nearly vertical are not infrequent. A very marked example is seen in the west face of the outcrop that runs southwest and cuts through both upper divisions of the section for more than fifty feet. At the top it passes through the west and lower part of the picket rock, causing all that part of the stone west of the seam to fall away and leave a smooth, vertical face. In no instance do these seams show that the relations of the strata have been disturbed. They appear to be due to the same causes which have produced seams, or a jointed structure, in all stratified rocks.

The fossils of the picket rock top of the section are so fragmentary as to render their identification difficult, but enough nearly perfect specimens were found to show that they were of the same species as those from the underlying quarry stone. This is the only exposure of the former stone which clearly shows that it does not reach the bottom of the latter strata. Near Charley Creek, in Wabash City, the picket rock seems to rest on the quarry stone, but does not clearly show that such is the case.

On Lagro Creek and at Hanging Rock the cement shale underlies the quarry stone, but this is true in certain localities. At the Martin Willis quarry and on the Salamonie River there is about fifteen feet of even bedded, buff, or ochery colored, laminated shale overlying the

cement shale. This formation differs, not only in color and want of hydraulic properties from the cement shale, but contains a much larger per cent. of argillacious matter. In it the proportion of clay is so large as to cause it to split into thin *laminæ* or plates. Typical specimens are found at South Wabash. As a rule the laminated shale underlies the quarry stone, but there are exceptions as at the Martin Willis quarry where it occupies the same level, and all over the county it, or the cement shale, will be found in connection with the quarry stone.

The quarry stone is probably the stratified surface stone underlying the drift of the whole county, except an occasional exposure of picket rock which replaces it. It is found outcropping in all the bluffs and ravines of the Wabash and Mississinewa Rivers, on Ross Run and Rockyway Creek, except where covered with soil and gravel, and in the high banks of the Salamonie. It shows in greatest force in the vicinity of Wabash, Rich Valley, Lagro and Somerset. It is generally of a buff or an ochery color. The color varies with the degree of exposure, and resulting higher oxidation of its constituent salts or iron. At places in South Wabash and near Lagro it presents a hard, dark gray appearance. Strictly speaking it is not an argillaceous or magnesian dolomite, but is more nearly a silicious limestone. Many of the strata are very free from flinty nodules, while others are almost wholly made up of chert. The cherty layers are mostly confined to the top of the formation and do not average more than one inch in thickness. Near the center of the exposure the ledges become two or more inches thick with occasionally an intercallated stratum of chert. The lower strata measure from six to twelve inches. Rarely the thicker strata are cherty, and when this is the case here, as elsewhere in all the Niagara stone, it is refractory and can only be used in rough masonry. Near Lagro, at the Kisner quarry, the middle members of the formation are cherty and coalesce. The cherty matter does not appear in stratified beds, but is generally disseminated through the mass, and cause it to break into rather smooth, round and oblong pieces, from one to four inches in diameter. On the Mississinewa River, and at some of the quarries west of Wabash in the river bluffs, the quarry stone exposures, by an increase in the number and thickness of the strata, reach a total thickness of thirty-five feet, but preserve the same lithological characters as those described as typical from South Wabash, where the outcrop does not measure more than seventeen feet thick.

The apparent identity of the top cherty member of the Wabash County quarry stone with the corresponding formation of Huntington County seems to show that the chert beds in both counties represent the close of the Niagara epoch. But it is not every outcrop which shows the top strata; in the vicinity of Lagro the denuding forces which have excavated the Wabash Valley have removed a part of the Niagara stone.

A most remarkable example of unconformability of the quarry stone to the cement rock was seen in the east bank of Lagro Creek, one-half mile north of Lagro, where the following sections were made:

SECTION ON LAGRO CREEK.

East ½ southwest qr. section 27, township 28 north, range 7 east.

Soil and slope	10 feet.
Blue cement rock, obscurely bedded, breaking with a distinct conchoidal fracture	30 feet.
Total	40 feet.

SECTION ON LAGRO CREEK.

Soil and slope	10 feet.
Hard limestone, equivalent of the quarry stone, with distinct and regular planes of separation	30 feet.
Total	40 feet.

The sections were made within a distance of twenty feet. The passage from the cement rock to the limestone is abrupt, and, viewed on a horizontal plane, looks as if one formation had been forced past the other by an upheaval. The dividing line between the formations is somewhat obscured by fragments of cement rock, but the relation of the two is very clearly defined. The hard limestone of the last section is readily identified as a modified form of quarry stone, but has characters that show it to be closely allied to the picket rock formation. It is without the characteristic shaley partings of the former, and has the physical appearance, crystalline structure, and cleavage planes of the latter. The top of the sections are on the same level, but the cement rock of the first passes down, without a break in its continuity, to the bottom of the creek and up the creek under the limestone beds. Here is an apparent fault of thirty feet. But the exposure, for quite a distance up the creek, under the limestone, shows that the peculiar relations of the two sections are not the result of a fault, and this conclusion is confirmed by a few clean cut, closed seams in the underlying stratum which are so nearly vertical as to exclude any idea that the rock in which they occur has been disturbed by an upthrust. The reader will not only note the absence of the laminated shale from both sections, but that in the second the base of the quarry stone drops thirty feet below the top of the cement rock. The dip, taken on the obscure planes of separation, is marked at the lower end of the outcropping limestone, but soon changes to nearly horizontal, and the stratification becomes distinct and can be plainly traced in prominent ledges, with shaley partings, up the creek for more than one-eighth of a mile, where the following section was made:

SECTION OF J. W. SHEETS' QUARRY.

East side of Lagro Creek, one-half mile north of Lagro.

Soil	8 ft. 0 in.
Thin bedded, gray limestone, with clay partings	3 ft. 8 in.
Heavy bedded, dark-blue quarry stone	1 ft. 2 in.
Heavy bedded, dark-blue quarry stone	2 ft. 6 in.
Heavy bedded, dark-blue quarry stone	1 ft. 6 in.
Heavy bedded, dark-blue quarry stone	1 ft. 0 in.
Total	17 ft. 10 in.

A short distance north the quarry stone and underlying shale disappear, owing to the slight dip and to the rise in the bed of the creek. The fossils seen were: *Lichenalia concentrica*, *Ichthyorachis*, n. s., *Zephrentis celator*, *Pisocrinus gorbyi*, and many of the Bryozoans common in the Waldron and Hartsville Niagara shales. Doubtless many other species will be found by the diligent collector. Near where the George Todd section was made an *Orthoceras strix* and the cast of a *Lituites* and *Pleurotomaria* were found in the cement rock of the creek channel.

It has already been shown that the apparent fault at the lower end of the quarry stone on Lagro Creek is not due to an upheaval, but it remains to account for the unconformability of the two formations just described. The most reasonable solution of the question, and one that agrees well with the facts, is that the quarry stone strata were deposited in a trough or valley in the cement shale, and that the first section made at the George Todd farm represents the south bluff bank of the valley. This probability is further corroborated by the quarry stone showing again in the Wabash River bluffs east of Lagro, indicating that the ancient valley had an east and west trend. At the Martin Willis quarry, on the Township Line Pike, is an exposure of the stratified quarry stone where the workmen have taken out stone at a lower level than the top of the adjacent laminated shale. The extent of the unconformability could not be determined, as the quarry has not been opened to the bottom of the formation, but enough stone has been removed to show an apparent fault of more than ten feet. Here the depression occurs in the laminated shale and occupies a different geological horizon from that in the cement rock on Lagro Creek, but they are alike in having an east and a west trend. The stratification of both formations is nearly level. Especially is this true of the shale in the Martin Willis quarry which outcrops in places west of the pike and between the quarry and the river bottom. The bedding of the underlying cement shale where it shows is quite irregular. Similar depressions in the shale occur elsewhere, and particularly at the quarry of Leonard Hyman on the Mississinewa River, in Waltz Township.

SECTION AT THOMAS BRIDGES' QUARRY.

Northeast part of South Wabash.

Thin, laminated limestone, slightly cherty	1 ft.	6 in.
Chert in thin strata	1 ft.	0 in.
Shale		8 in.
Thin, even bedded limestone	1 ft.	4 in.
Chert stratum in limestone matrix		4 in.
Even bedded flag, strata averaging two inches in thickness	8 ft.	8 in.
Shale		3 in.
Hard, blue, even bedded dimension stone		10 in.
Hard, blue, even bedded dimension stone		9 in.
Hard, blue, even bedded dimension stone		7 in.
Laminated shale, not measured		
Total	18 ft.	7 in.

This quarry is located on the top of a ridge, one face of which is formed by the river bluff and the other by a deep ravine or valley running east and west through the town, and is a typical quarry of the vicinity. Other sections will show variations in the succession of the chert, shale and limestone layers, and in the thickness of each stratum, but the average total thickness of the exposure is nearly constantly found to be nineteen feet. In the south face of the quarry, near the ravine side of the ridge, is a fissure or seam filled with earth two feet wide at the top and bottom. The stone between the fissure and the ravine has the appearance of having separated from the mass by bodily sliding toward the valley, and now rests on a very insecure base. A few feet north is another seam that is uniformly fifteen inches wide, but does not reach down to the shale. A number of other seams of less width were examined and all found filled with earth, and of nearly the same extent throughout. They are called "dirt seams" by the quarrymen and have no special features to distinguish them from similar seams in the quarry rocks of Southeastern Indiana. Several hundred feet of the surface of the laminated shale has been exposed by the quarrymen and it is almost perfectly level. No place was found in the immediate vicinity where its thickness could be measured, but in the bluff at the south end of the iron bridge over the Wabash River, it outcrops in strata that soon pass into the compound bedding of the cement shale and the latter into the hydraulic limestone.

Having, in a general way, described the stratified formations of the county, it remains to take up the picket rocks and treat of them in the same manner. Because of their very peculiar structure, and relations to the other subdivisions of the general section, they have been left until the last for consideration. In vertical exposure they always reach the level of the top of the adjacent quarry stone. Wherever their relations to the underlying strata could be seen they never were found

resting on the laminated shale. The laminated shale frequently lies on the sides of the picket rocks, but under them has constantly been found some form of homogeneous stone, either cement rock, hydraulic limestone or limestone and shale.

The striking and diagnostic features of the formation are its outcroping in cone-shaped masses, with so-called stratification lines dipping to all points of the compass, or as an irregularly shaped deposit with lines of separation in one or two directions only. Typical cones appear to be the result of an upheaval. It is a hard, solid or spongy crystalline limestone that readily burns to lime. The spongy structure is due to cavities, ranging from one-sixteenth of an inch to an inch in diameter, which do not affect the hardness of the stone. The exterior of the exposure is rough, and looks as if it might have resisted the eroding effects of summer and winter for ages. The color is generally gray or grayish white, and varies with the composition of the stone. It shows no tendency to split, and breaks into irregular, angular fragments. The cone at Wabash is typical as to form and structure. The lithological characters of typical specimens of the formation are unlike any other stone seen in the county. The only formation with which it might be confounded is that of the quarry stone. Compared with the thicker beds of the latter, the picket rocks are seen to be more highly crystalline, massive, and generally of a uniform color and structure throughout. When the color and structure of a specimen does change within the mass, the stone never shows the stratified parallel bands of crystallization or blue, gray and buff color seen in the ten and twelve inch strata of the quarry stone. The marked appearance of stratification common to all the quarry stone layers is wanting in the typical picket rocks. At many places the one formation passes into the other by imperceptible changes of color and structure.

It is possible that circumscribed deposits of picket rock occur throughout the county under the Drift, but it is only exposed in the river bluffs. It outcrops in the eastern part of Wabash, at the north end of the Cincinnati, Wabash & Michigan Railway bridge; east of Charley Creek, and north of the Wabash Railroad; near the south end of the old wooden bridge over the Wabash River; on the farm of William P. Stanffer, two miles west of South Wabash; east of Rich Valley, on Rockyway Creek, near New Holland; at Dora; in the top of Hanging Rock; at the Narrows; one-eighth of a mile west of Lagro, on the Wabash & Erie Canal; in the east bank of the Salamonie River, one and a half miles above its mouth; on Lagro Creek; at the mouth of the Watson Briggs Ravine, and at Belden.

SECTION AT DORA.

East End of the Wagon Bridge Over the Salamonie River.

Soil and slope	10 ft.
Cone-shaped mass of rough, dark colored picket rocks	12 ft.
Horizontal cement shale and hydraulic limestone to the water	25 ft.
Total	47 ft.

SECTION AT DORA.

In the West Bank of the River Below the Mill, and Nearly Opposite the Preceding Section.

Soil and covered slope	4 ft. 0 in.
Amorphous cement rock and cement shale	18 ft. 0 in.
Stratified, blue hydraulic limestone, dip 2° north	1 ft. 6 in.
Amorphous, blue stratum	2 ft. 6 in.
Total	26 ft. 0 in.

The last section is equivalent to the lower twenty-five feet of stone imperfectly exposed on the opposite bank of the river under the picket rocks. The two sections are separated only by the width of the river, and taken together exclude all idea of either one ever having been disturbed by an upheaval. The picket rock outcrop is in the form of an oblong cone, three hundred feet long by twelve feet thick, with its long axis parallel to the bluff. The dip on the north end is markedly to the north and to the opposite point of the compass at the other end; on the river front it is distinctly to the west. The dip on the lines of separation is not so acute or irregular as that of the typical cone, but is well marked, and when taken with the physical characters of the stone clearly identifies the formation with the picket rocks And, while there is very little evidence that the cone is directly due to false or compound bedding, it is very probable that it rests on irregularly stratified cement rock; but the want of marked false bedding does not prove an upheaval. It is not conceivable that a mass of stone three hundred feet long by twelve feet thick and of an unknown width could have been forced into its present position from below, or the dip changed to such a degree and leave the strata in the immediate vicinity undisturbed. Neither theory seems to be a satisfactory explanation of the phenomenon. At Hanging Rock the equivalent beds are unstratified; here the lines of separation are obscure and resemble fracture lines or joint seams. These fracture lines preserve a rough parallelism, and are generally referred to as lines of stratification. If a shale or clay parting between the so-called strata is essential to true stratification, the picket rocks of Wabash County are not stratified; and it is scarcely conceivable that in true stratification they should not occasionally occur. In explanation, it is proper to say that it is not here claimed that there can not be stratification without clay or shale partings.

The parting may be "dry"—that is, without either clay or shale between the layers—but in every case of true stratification there is a peculiar changed appearance of the surface of the bedding, and the internal structure of the stratum shows chert or color bands that readily indicate that the stone under observation may be classed with the stratified rocks. It is not so with the picket rocks; the lines of separation seen in them show no surface changes on the bedding. They are devoid of regular, parallel bands of chert, color, or altered internal structure. Whatever internal changes they may show indicate that the mass has been disturbed.

The quarry stone is not exposed near by, but is replaced by the picket rocks, which cap the cone on a level with the top of the bluff. The laminated shale occurs at both ends of the exposure, and at the south end passes into the cement shale.

The very remarkable exposure at the north end of the Cincinnati, Wabash & Michigan Railway, in Wabash, may be considered as not only typical of the formation in the county, but also of the Wabash Valley from Delphi to Huntington. This exposure is four hundred feet long and thirty-five feet high. The dip on the so-called lines of stratification varies from forty-five to sixty degrees and covers all points of the compass. It has so much the appearance of being the results of an upheaval as to attract the attention of the most careless observer. The cone rises to a level with the uplands, and presents a gray, stony surface down to the railroad track that forms a conspicuous landmark when seen from the bluffs and approaches to the city south of the river. The base of the cone below the outcrop is covered with soil and gravel. The magnificent exposure of equivalent stone on the south side of the river near the wooden wagon bridge is confined to the same level in the top of the bluff, and seems to rest on the cement rock. The hydraulic limestone in horizontal strata is well exposed in heavy beds a short distance east on Treaty Creek, and is imperfectly exposed at a short distance west, at the south end of the iron bridge.

The lines of separation between the strata of the Wabash Cones are so far removed from true stratification as to show that they are due to some other cause than sedimentary segregation. They seem to be due to the same causes which have produced one form of cleavage structure, and hereafter they will be referred to as cleavage planes.

The bedding of the cones at Wabash is very remarkable for its compound character, and the rapidity with which the planes of cleavage change. A general rule governs and keeps the plane within certain bounds so that they are never at right angles. Looking up the long axis of the cone from the west end, the surface of the exposure is seen to rise and fall like waves. Standing in front where the exterior layers have been removed, so as to get a cross section of the waves, it is seen that the undulating appearance is due to the thinning and thickening of the strata,

and to intercallated lenticular shaped masses of stone. One mass was seen that measured five feet through the short and fifteen feet through the long axis. Vertical and diagonal seams occur, but should not be confounded with the cleavage lines, which they somewhat resemble. Where vertical seams occur they are closed and never show faults or other evidence of a sliding movement. Where they occur the stone is broken into angular fragments that complicate and appear to contradict the general law mentioned as governing the irregular cleavage planes. The vertical seams in the cones at Wabash, and across the river, may be readily distinguished from the cleavage lines by the scratched or furrowed structure which shows on the cleavage surface and not on the other. This furrowed appearance is confined to the interior layers, and is shown in both outcrops here by the removal of a part of the cones—in the one place to give room for the railroad tracks, and in the other for making lime. That the cone on the Salamonie River, and below Lagro, may show the same internal structure is very probable, but if the theory of their origin, to be explained further on, is correct, it should not show on the outside layers. Closely examined, the cleavage planes appear as if covered with columnar furrows and slight ridges. In general appearance the furrows are identical with the columnar structure of the suture joints, or crow feet of the quarrymen, found between and at right angles to the horizontal stratification of the Niagara and St. Louis Group limestone. Elsewhere than in the picket rocks the columnar structure only shows when the stone is broken at an angle to the bedding. Here its long axis is parallel to the seam and is plainly visible on the cleavage surface which it covers, except when it is obscured by a deposit of calcite. These furrows and ridges are longer than those commonly seen in suture joints, and measure from one to four inches in length by from one-sixteenth to one-half an inch in diameter. The interior of the picket rocks also frequently disclose the form common to the Niagara Group stone, and this interior structure should not be mistaken for that confined and peculiar to the surface. The columnar structure on the exterior of the stratum reminds one very much of the surface of a colony of Favosites, and that of the interior resembles a short, longitudinal section of coarse wood fibre. In addition to the greater size of the surface furrows and ridges, they have a peculiar cone-in-cone appearance that is due to faint corrugation lines that cross the sides of the furrows at an angle. The corrugations have corresponding internal conical diaphragms with the point of the cone directed downward. Occasionally there is an air space between the diaphragms where the point of the cone does not quite reach to the bottom of the concavity below. These air spaces in part account for the spongy character of the stone. Specimens of stone taken from the top of the Wabash Cone, where the Cincinnati, Wabash & Michigan Railway Company were quarrying and crushing it for railroad ballast, show that its internal structure is not

homogeneous. It more nearly resembles a hard, solid breccia than an even textured sedimentary rock. Careful inspection shows that the fragments are made up of irregular, angular masses of buff, irregular bands of blue, and cavities lined wlth quartz crystals, all imbedded in white crystalline limestone. Occasionally thin scales of blue shale were found between the bands of buff and blue limestone, and on the top of the distorted internal columnar structure. The stone appears as if it were the result of an imperfect mixing of the different strata of the adjoining quarry rocks while they were yet plastic, with the addition of crystalline matter. The quarry stone and the top of the exposure are on the same level, and both formations occupying the same geological horizon is very suggestive as to the origin of the materials of a portion of the cones. These, and other picket rock exposures are described as cones, but the reader will bear in mind that the term is not used to indicate an isolated hill of stone. The cone north of the river at Wabash rises slightly above the laminated shale because the quarry stone in its immediate vicinity has been eroded away by the forces which have excavated the Wabash Valley, but were powerless to reduce the adamantine picket rocks. The cone south of the river does not rise above the top of the bluff, and viewed at a distance looks like a great mass of smooth, dark stone set in a high earth and gravel bank. It is only when the observer approaches near and examines the dip in front and on the sides of the exposure that he discovers the true form of the outcrop.

SECTION ON WILLIAM P. STANFFER'S FARM.

One and one-half miles west of South Wabash.

Soil	3 feet.
Hard gray picket rock obscurely bedded, dip ten degrees west, in only one direction	40 feet.
Covered slope (shale?)	20 feet.
Total	63 feet.

This exposure is in the bluff that forms the south wall of the first terrace one-fourth of a mile back from the river. The massive wall of the outcrop rises in a sheer precipice forty feet high by one thousand feet in length. Its dark and frowning front, covered with gray lichens, look as if only eternity could reduce it to dust. The cleavage lines are obscure, closely resembling ordinary fracture seams and might be classed as such if they all did not have the same general dip. Passing west along the bluff, the dip of the massive stone at the lower end is seen to change from ten degrees, and gradually become horizontal, the lithological character of the formation at the same time changing, first into even bedded buff limestone and this last passing into thin bedded cherty quarry stone,

One-eighth of a mile west of the last section the following section was made on the farm of John Ridenhour:

SECTION AT SHANTY FALLS.

Soil	1 ft.	0 in.
Thin bedded, cherty quarry stone, weathered into large cavities	35 ft.	0 in.
Heavy bedded, gray limestone	1 ft.	6 in.
Heavy bedded, gray limestone		10 in.
Heavy bedded, gray limestone		10 in.
Gray laminated shale	20 ft.	0 in.
Total	59 ft.	2 in

In the ravine at this place there is a picturesque fall of twenty-two feet formed by the little stream having cut through the cherty layers until the thicker strata are reached overlying the shale.

The picket rocks of the Stanffer section are striking examples of the absence of all evidence that they are the result of an upheaval. The horizontal and vertical extent of the exposure, together with the uniformity of the slight dip in one direction only, and the gradual transition into typical quarry stone point to some other theory of their origin. On the other hand the absence of true stratification and the structure of the stone are so characteristic as to leave no doubt as to their classification. The two sections taken together seem to indicate that the materials of both are of a common sedimentary origin and that the picket rocks are nothing more than modified quarry stone. The top of the quarry stone at Shanty Falls is slightly lower than the top of the picket rocks, and the same is true of the two formations on Lagro Creek and at Rockyway Falls. At Hanging Rock the latter formation does not show cleavage lines, here they are obscure, and at Rockyway they very nearly approach stratification.

SECTION ON ROCKYWAY CREEK.

Two hundred feet below Rockyway Falls, N. E. Qr. Sec. 19, *Town.* 27, *Range* 8, *East.*

Thin bedded, nearly horizontal, quarry stone made up of 60 strata ranging from one to four inches thick, with shale and clay partings	12 ft.
Underlying hard, blue shale, not measured	
Total	12 ft.

At the falls the dip is 38 degrees north, 20 degrees east; twenty feet below the dip is 8 degrees, and one hundred and fifty feet below it is 14 degrees. Following up the creek from the point at which the section was taken, the banks are precipitous walls of stone until the falls are reached. The ascent over the falls is not abrupt, but follows the dip of the cleavage. From here to the road the edges of the layers present to the surface and cross the stream at right angles. If the reader will imagine a channel one thousand feet long, twenty feet wide and twelve feet

deep filled with broad sheets of stone ranging from four to eight inches in thickness placed at an angle of 38 degrees, the edges of the layers pointing up stream, he can form an imperfect idea of the appearance of the creek bed above the falls. The general statement that the dip is 38 degrees north of the falls is true as to the upper two-thirds, but the lower third becomes more nearly horizontal by a gentle curve in the layers that is clearly shown in the side wall of the channel. Here, again, the gradual change from picket rock to quarry stone is very readily traced, and scarcely leaves a doubt as to their being of the same geological age. Examined above the falls where the upturned edges of the stones are prominent, the cleavage seams are found to be enlarged by erosion, and seem to indicate true stratification; but that it is picket rock is evident from its external appearance alone. Add to this the internal structure and the absence of shale parting and it amounts to a demonstration. The Rockyway Section also shows by the fossil remains found in it, that the formation above and below the falls belong to equivalent beds of stone. On the farm of Mrs Thomas, one-half mile south of the falls, the extension of the picket rock beds was found in digging a well at the depth of forty feet. Supposing these exposures to be continuous, and the result of an upheaval, would make the Niagara Group stone here 1,859 feet thick after making due allowance for the dip, nearly double the recorded vertical extent of these rocks anywhere in the State.

The Narrows or Black Pool, one mile south of Lagro and Township Line Pike, is an exposure of picket rocks similar in dip and cleavage to that of Rockyway Falls. Having referred to the cañon-like defile which cuts the face of the bluff, it is called the Narrows; having reference to the dark basin of water at the foot of the Narrows under the toppling rocks, it is known as the Black Pool. Hidden away from the highway in a dense forest, as it is, the traveler would never suspect the existence of a place of such romantic and geological interest. The little rivulet that runs from the pool down to the road passes over twenty feet of hydraulic limestone and cement shale. The rock overhanging the pool and mouth of the Narrows is twenty feet high, very massive and obscurely divided into huge blocks by cleavage lines which dip down the rivulet at an angle of thirty-five degrees. The defile is one hundred and fifty feet long, at first narrow and shallow until it is about eight feet wide and the walls more than twelve feet high. Its course is crooked, some of the bends being nearly at right angles, and it has a fall of twenty-five feet from the top of the bluff to the foot of the Narrows. In its upper course the dip increases to forty-five degrees, and vertical and cross seams become very numerous. The numerous seams have broken the stone into small fragments, many of them not much larger than the fist. This broken condition of the layers is in strong contrast with the massive rock at the foot

of the Narrows, and is in part due to the pressure of cherty matter. Even bedded quarry stone occurs near by, at the Martin Willis quarry, and laminated shale shows abundantly in the adjacent bluffs. The obscure cleavage and massive character of the stone at the Black Pool strikingly resembles that of the equivalent beds at the Stanffer Farm and Hanging Rock. The whole of this exposure is peculiar in being the only place seen where the picket rocks show surface erosion, and a part of it is unlike any other outcrop, as the only place where the stone was broken into small fragments. Looking at this geological freak of nature, the question arises, how was it formed? The little stream which flows through the defile at the present day has not sufficient power to wash away the slime and moss that covers the floor of the channel, much less wear away the hard stone. The greatly increased dimensions near the mouth indicate that it is the result of the same forces that excavated the Wabash Valley. It is probable that the glen, of which the Black Pool and the Narrows are a part, was once a wave swept cove, and that the waves acting from below were the instruments in the hand of Nature for doing this fantastic work.

The picket rock sections described in the foregoing pages, with one exception, do not present any appreciable difference in the lithological structure of the stone, whether taken from the top or the bottom of the section. The exception was seen in the East Wabash Cone, where the quarried rock has an ochery color, and physical characters quite different from the stone at the base near the railroad tracks. The remaining picket rock sections and descriptions are introduced to illustrate these changes. One-fourth of a mile below Lagro, in the bluff on the north side of the Wabash & Erie Canal, is a well-marked cone where three divisions or grades of stone are shown in a vertical section.

SECTION WEST OF LAGRO.

Fossiliferous Picket Rock Limestone, the Equivalent of the Quarry.

Stone strata.	18 ft.
Cherty picket rock, same age as the quarry stone	15 ft.
Gray picket rock limestone, weathering to buff, cleavage well marked . .	17 ft.
Total	50 ft.

The measurements here given are estimated, as it was not practicable to get them accurately on the uncovered and precipitous surface of the cone. The vertical limits of the divisions are not well defined, and so gradual are the changes from the one to the other that no two observers are likely to make the thickness of each the same. At the east end of the section the blue cement stone passes into gray stratified limestone and the stratified material is built up by compound bedding until it stands at

an angle of thirty to forty degrees. At the west end the slope is particularly covered with earth, but the shale shows half way up the side. Here, and at the J. D. Shultz Cone, on the Salamonie River, the cones are well defined, and look as if they had been first built and the remainder of the bluff deposited around them on three sides leaving the river front bare. The horizontal transition of quarry stone into picket rock has already been shown, and it is not difficult to grasp the idea of a chemical change so far modifying the former as to give it the character of the latter; but to conceive that cement shale has been transformed into picket rock is not such an easy matter. The fossiliferous and cherty divisions of the last section are undoubtedly of the same geological horizon as the quarry stone, and it is equally certain that the lower seventeen feet has been derived from the adjacent shale. The best example of the modified lower picket rock limestone was seen south of the Wabash River, in the Watson Briggs Ravine, about one mile west of Lagro.

SECTION AT THE WATSON BRIGGS RAVINE.

Upper Section of Reservation No. 14.

Hard, crystalline picket rock	10 ft.
Transition limestone	5 ft.
Cement shale	10 ft.
Total	25 ft.

No single section can give the variable thickness of the divisions, and the whole exposure is peculiar in being the only one in which the cleavage lines are in opposite directions from the center. At all other points the cleavage has been found running all in one plane or in every direction from a common center or oblong cone. The ravine cuts a channel forty feet wide in the bluff nearly down to a level with the river terrace. Near the mouth of the ravine its banks are very steep and rocky. On the west side the wall for three hundred feet is made up of picket rock that forms an arch over a central cone of cement shale. The arch appears as if it was formed by removing one-half of a cone, and this may have been the case, but does not seem probable, as the wall on the opposite side of the narrow ravine, narrow when compared with the length of the arch, is composed of irregularly bedded hydraulic limestone dipping twenty degrees south, the cement shale overlying the even bedded, horizontal quarry limestone. The ends of the arch are about twenty-five feet thick where it dips down to the bottom of the ravine and passes under the surface. Taken on the cleavage lines at the ends the dip is at first twenty degrees, then twelve degrees, and gradually less until the planes are horizontal over the center where the section was made. The middle division of the section overlying the central cone of

cement shale is five feet thick and presents a hard, dark-weathered surface and a dark gray, homogeneous, noncrystalline interior. This stone is a fairly pure limestone and is used by the Lagro Cement and Manufacturing Co. for mixing with the cement rock to increase the quantity of the quick-lime in the finished product.

By taking a boat above the dam near the mouth of the Salamonie and rowing up stream a beautiful exposure of the hydraulic limestone is seen in the west bank of the river. For half a mile the stone rises in a perpendicular wall from ten to fifteen feet high that forms the base of the high bluff. As a general rule the bedding is even, with an occasional stratum which thins out or grows thicker on long lines. Vertical fractures are not numerous and are all closed seams. On the east side of the river, a short distance above, where the hydraulic stone passes under the slope, is a cone which rises from below the water's edge to the top of the bluff. Its exact height was not measured, as neither of us cared to risk a fall into the water, but it is estimated to be about fifty feet. It is proposed that this exposure of picket rock shall be known as the J. D. Shultz Cone, in honor of Rev. J. D. Shultz, of Lagro, who took us to this and many other points of great interest, which, without his intelligent guidance, we probably would not have seen. In passing up the river between the high bluffs, if the voyager expects to see a mass of rock standing out from the bank in bold relief, as the name would seem to indicate, he will be disappointed. The dip of the river front of the cone is parallel with the slope of the bluff at an estimated angle of sixty degrees. At each end of the outcrop the dip is north and south at the same high angle. The south side of the cone has irregularly bedded cement rock resting unconformably against it, which farther up the stream becomes horizontal and gradually passes into laminated shale. A portion of the river front at the south side does not come quite to the water's edge and is deeply undermined, indicating that this part of the cone once rested on shale which has been eroded away by the river. In this outcrop and the one below Lagro, the high angle cleavage planes come nearly down to a level with the hydraulic limestone which is seen in force near by in the river banks. But it is especially interesting to note that here the lower member of the cone, just above the water, is the exact counterpart of the transition stone seen at the Briggs Ravine and at the Lagro Cone. These exposures were the only ones of considerable vertical extent which were seen whose formations are laid in the cement shale or hydraulic limestone, and which clearly exhibit the modified lower members of the cone passing into shale.

In concluding the section on general geology the following extracts from other observers who have written on the geology of the Wabash Valley are introduced for the purpose of corroborating and completing the descriptions already given of equivalent formations in the county.

A very interesting outcrop of picket rocks in the railroad cut, one-half mile east of Rich Valley, is described in Indiana Geological Survey, 1859–60, page 68, by the late State Geologist, Prof. Richard Owen. He says: "Entering at the west end we find beds inclined to the west at an angle of 45°; approaching the center, an anticlinal axis partakes rather of the character of curved or folded strata, with huge masses of the purest crystalline calcite, partially covered by a crust of tufa. This is doubtless derived by infiltration from the calcareous matter of the superincumbent Drift, as somewhat farther east we encounter gravel, sometimes consolidated by this cement into a hard conglomerate, resting now on beds that occupy the railroad level, although at the center of the cut these strata were nearly thirty feet over our heads. Beneath this bed we discern chert, sometimes pure and detached, sometimes apparently the result of silicious filtration into the cavities of the limestone. Emerging from this remarkable section at the eastern end, we find shales with an easterly dip at the rate of about 25°."

The present State Geologist, Prof. S. S. Gorby, in the 15th Report, page 231, says: "In the vicinity of Belden, Wabash County, the limestones are tilted to a great degree, and they dip in every direction. The river at this point seems to be following the course of an anticlinal, as on the south side of the river the rocks dip east, south and west, while on the north the dip is generally north or northwest. The extent of the dip on the south side of the river is from twenty to sixty degrees, while on the north it varies from twenty to forty-five degrees. Occasional exposures are seen here also, where the rocks lie in a nearly horizontal position. There is one point, however, on the north side of the stream, a mile or so west of Belden, where the dip is to the south to the extent of about twenty-five degrees.

"Throughout this whole extent of territory, where the rocks have been exposed by the denudations of the Wabash, scarcely two closely connected points will show the strata in the same position. At one point they dip abruptly to the north, while at another, only two or three rods away, they dip strongly to the east or west. Cone-shaped masses are common. The quarries reveal them, semi-circular, with the strata dipping in every direction from the summit."

DYNAMIC GEOLOGY.

The presence of alumina in the hydraulic limestone indicates that they were deposited from impure waters, and the absence of fossils shows that the conditions were unfavorable to animal life. The even, horizontal bedding shows they were formed at the bottom of a sea unswept by currents and tidal waves. During the time in which the cement shales were in process of formation the conditions had very materially changed. The

semi-impurity of the waters continued, but the compound bedding points to the existence of currents and waves of no mean power. Standard text-books on geology teach that irregular bedding is of three kinds: beach structure, the ebb-and-flow structure, and the sand-drift structure, each having a different origin, as the names indicate. It is self-evident that none of the rocks of Wabash County are the result of a sand-drift. The very great irregularity in the thickness of the strata, which rapidly thin out on short lines of bedding, point to their origin on a sea-beach, but rendered improbable by the uniformity of their lithogical structure. Dana's Manual of Geology, page 93, in describing the ebb-and-flow structure, says: "The bed, although it be but a few feet thick, consists of layers of various kinds, some of which are horizontally laminated and others obliquely so, with great regularity. The successions of members indicate frequent changes or reversals in the currents during the deposition. Such changes attend the ebb and flow of the tides or tidal currents or waves over a shallow bottom." And it is doubtless largely to such conditions as these the compound bedding of the cement shale and amorphous cement rock is due. Overlying the cement shales come the laminated shales and quarry stone beds, which are approximately level, indicating that the sea had again become quiet. The water, however, was charged with clayey matter while the laminated shales were being deposited, and the frequency of shaley partings between the quarry stone strata show that the sea was still at times muddy, but not to such an extent as to destroy animal life.

While the uneven surface left by the compoundly bedded cement rock was the foundation and primary cause of subsequent irregularities, the subsequent irregular bedding was not alone due to currents and tidal waves. The presumption that all strata formed at the bottom of a quiet sea must originally have been level was disproved by a very remarkable section exposed in the south side of the James Lambert quarry in South Wabash. Here was seen a plano-convex mass of shale seven inches thick in the middle, and six feet long, intercalated between the quarry stone layers. Below the mass several strata of even bedded, horizontal stone were exposed, while the strata above passed over the shale as if they had been separated when plastic and the shaley mass inserted between the layers. The overlying strata were about an inch thick, with an east and west dip, on the sloping sides, of twelve and sixteen degrees. The curved strata did not show fracture lines or sensible evidence of thinning on the anticlinals. This illustration of the origin of a tilted structure, however, is seldom applicable to the quarry stone of Wabash County, which was generally deposited on a level surface, but explains many of the irregularities seen in the equivalent beds at Huntington. It explains the formation of the synclinals in the Hippskind quarry, east of Wabash

and at Hanging Rock, and the anticlinal in one of the quarries near the mouth of Charley Creek

While the greater part of the quarry stone of Wabash County was deposited on a level plane, formed by the laminated shale filling up the uneven superior surface of the cement rocks, there are marked departures from this rule where the laminated shale is absent, as at the Todd farm, on Lagro Creek; at the Martin Willis quarry, and at the quarry of Leonard Hyman, on the Mississinewa River, where the lower part of the formation is below the common level of the under surface of the quarry stone. At the Stauffer farm and the William Moelering quarry the bluffs have nearly the same relative height above the river as at South Wabash, and show thirty-five feet of quarry stone against less than twenty feet at the latter place. The reasons have already been given for believing that the top of these sections are of the same geological age, and represent the close of the Niagara Period. That the top of the country rocks should present an uneven surface, diversified by hills and valleys, is accepted by every one as a matter of course, without reflecting that the contour of the under surface of the formation may be nearly as irregular. It has been suggested that the origin of these anomalous irregularities may be accounted for by the theory that the quarry has been deposited in a trough or valley in the laminated shale. Any other theory would make the shale of the same, or of a subsequent geological age to the quarry stone. It seems probable that while the sediment which forms the laminated shale was falling from the sea generally over the uneven surface left by the ebb-and-flow period of the cement rock there were places still swept by currents, which carried away the sediment and produced valleys that were subsequently filled with quarry stone.

The unequal shrinkage because of the unequal density of the shales during the process of lithification was another factor in the distortion of the quarry stone beds and the picket rocks. It has already been shown that the laminated shale does not occur uniformly under the quarry stone, but is frequently replaced by cement rock, and it is easy to understand, where the one form of shale passes into the other, how the greater shrinkage of the one will cause the overlying rocks to dip, and perhaps otherwise disturb the strata.

Compound bedding, conformation to irregular surfaces, and unequal shrinkage, either alone or in combination, are sufficient to explain the variations of the dip in true stratification, but fail to account for the phenomenon where it exceeds twenty-five degrees. Some other theory must be applied to the rocks in which a high angle dip is the most obvious feature.

The generally accepted theory of the origin of the picket rocks is that they are the result of an upheaval, and the supposed upheaval is regarded as a satisfactory explanation of the related phenomena. The

tilted condition of the stone, and the presence of laminated shale apparently resting unconformably against the sides of the cones are the strong points in favor of the theory. And it is granted that the unconformability of the two formations is a very strong argument and might be accepted as conclusive were there not exposures where the underlying rocks can be seen and studied. Such exposures are not infrequent, and show stone of the same geological age and identical in structure with that of the Wabash Cone resting on cement shale and hydraulic limestone, which have not been disturbed since they were deposited on the bottow of the ocean. The origin of the Dora Cone, those in the vicinity of Lagro, and the picket rocks generally, must be accounted for in some other way. Without appealing to the testimony of the underlying rocks, there are other facts in the geological history of the Wabash County Cones, and of the whole State, so far as seen by us, which render the application of the accepted theory very doubtful. It has been shown that the top of the picket rocks are of the same geological horizon as the quarry stone, never higher or lower, and it is difficult to understand how a subterranean force acting over many miles of territory and through thousands of feet of stone could have been graduated in power, and so timed, as to form cones not exceeding a few hundred feet in extent, all reaching in altitude the close of the same geological period and nearly the same geodetic level. No such uniformity and limited results have been recorded of mountain ranges. Gas explosions as factors in the supposed upheavals are excluded because of their erratic effects. The argument here presented is only applicable to the isolated exposures of picket rocks, and is not in any way intended to apply to the question as to the existence of the Wabash Arch described in the Fifteenth and Sixteenth Indiana Geological Reports. It can be readily understood how long stretches of coast line were gradually elevated, or how a broad axis like the Cincinnati Arch may have been formed. But it is another matter to apply the same slow processes or broad movement to the growth of the Wabash County Cones, where the vertical movement has been confined to inches over an area measuring a few feet in diameter. That the vertical movement is confined to inches has been demonstrated by showing that the materials composing the picket rocks have been derived from the adjacent and equivalent stratified stone. Careful examination will convince any one of the truth of the last statement, and it is not necessary to add anything more in the way of confirmation.

In many places the unconformability of the strata is more apparent than real. At the Todd Farm Section the unconformability is real, and due to the deposition of the quarry stone in a depression in an older formation, but is not equal to a fault in the sense that one stratum or formation has been forced past the other. There is unconformability at

the Wabash Cone, and in many other places, in the sense that one formation does not pass into the other on the same horizon, and a real fault to the extent of a few inches. By the term "fault" it is here meant that the materials which have been transformed into picket rocks have been slightly displaced from their primary place in the bedding. In a rough way the picket rock cones and other exposures bear the same relation to the Niagara Period rocks, taken as a whole, as a mass of chert does to the stratum in which it is imbedded. The internal structure of the mass lies unconformably to the stratification bands of the stratum, and, if in the process of lithification the mass has been displaced by shrinkage or otherwise, a slight fault will be produced. And in a still rougher way the chemical processes which have resulted in chert are the counterpart of the changes that have transformed the quarry stone and laminated shale into picket rock. The infiltrated calcite described by Professor Richard Owen as occurring at the Rich Valley Cone seems to furnish a clew to the chemical processes involved long before the date assigned by him, but does not help to elucidate the related phenomena or explain how the changes were initiated.

It is well known to collectors that fossils may be either calcareous or silicious, as the chemical composition of the matrix is slightly varied. Under certain conditions a fossil may determine the shape of a silicious geode a thousand times larger than the mould on which it is built, or the fossil may furnish the starting point around which a large concretion has grown and the fossil still retain its original form. And while our knowledge of the processes by which the sedimentary products of the ocean have been converted into stone is imperfect, enough is known to warrant the conclusion that by chemical action certain isolated patches of stone in Wabash County have become more highly calcareous than the surrounding strata, and that a break or disturbance of the strata was the nucleus from which the chemical changes spread. The first effect of the disturbance was to re-expose the broken strata to the action of the water of the ocean and initiate chemical changes which obliterated the stratification of the limestone and shale beds and rendered the amorphous mass more highly calcareous. While the chemical changes were in progress, cleavage lines were formed which cut the original bedding at a high angle.

No matter what the disturbing element may have been, whether an upheaval or something else, the supposed stages of lithification were necessary to account for the final product. The changes must have occurred while the material was still plastic, as a disturbance at a later date would have resulted only in masses of broken rock and shale, identical in structure with that now found in the undisturbed strata. This theory is corroborated, notwithstanding the brecciated form of the stone, by the bent and tortuous course of the color lines in the top members of the Wabash Cone, and the bands of the buff and blue show that the

strata had sufficient consistency, before the disturbance, to preserve the characteristic colors of the quarry stone. It is possible the theory here presented may be made clearer by applying it to the life history of the Wabash Cone. At the close of the Niagara Epoch all the sedimentary deposits which now form the various grades of Niagara limestone and shale were in place. The stratified material of the hydraulic limestone beds, the lowest and oldest of the series exposed in the county, was probably of much its present degree of hardness on the same level that is shown by the outcrops above the mill on Treaty Creek and near the south end of the iron wagon bridge. On the hydraulic limestone rested the cement rock thrown into cones, ridges and slight valleys by irregular and compound bedding. The surface irregularities of the cement rocks were generally, but not wholly, filled up by the superimposed laminated shale, and over all came an unbroken sheet of quarry stone of uniform structure throughout. Because of the absence of the laminated shale on the higher cement rock cones and ridges, the foundation of the quarry stone was of unequal density, and it was at the points where the cement rock came in contact with the overlying quarry stone that the strata were afterward transformed into picket rocks from Huntington to Delphi, and perhaps further west. The central core of the Wabash Cone rested on one of these hard cement rock cones, surrounded on all sides by the less dense laminated shale, like the cones and other exposures in the vicinity of Lagro. After the process of lithification was sufficiently advanced to give the characteristic color to the quarry stone beds, the equilibrium of the mass was disturbed by the unequal shrinkage of the shales under the cone and surrounding it. That the shrinkage was greater in the laminated shale seems evident from the dip of the quarry stone strata falling away from the cones on the slightly lower level of the laminated shale.

It has already been pointed out that the picket rock lines of separation partake of the characters of both joint and cleavage planes. As to their origin Prof. James D. Dana says: "Joints are due to the same cause as slaty cleavage and may occur in slaty as well as other rocks." But it should be borne in mind that the layers of the picket rock formation differ from slaty cleavage in not being susceptible of further subdivision on the same plane. On this subject Sir Archibald Geikie in his text-book on Geology, second edition, pages 289-90, says: "More recently (1884) Fisher has proposed the view that in nature it is not to the pressure which plicated the rocks that cleavage is to be attributed, but to the shearing movement generated in large masses of rock left in a position too lofty for equilibrium. If such, however, had been the origin of the structure it is difficult to understand why there should be such prevalent relation between the strike and the cleavage, for if descent by gravitation were the main cause we should expect to find the rocks sheared far more irregularly than even the most irregular

disposition of cleavage. That in cleavage, then, has been true shear of the rocks is indubitable; and the amount of shear may be ascertained by the extent of the distortion of fossils in the planes of cleavage." The unstable equilibrium of the mass of stone on the cement rock cones and ridges exactly fill the conditions required by Mr. Fisher's theory, and notwithstanding the objections urged against it seems to be a satisfactory solution of the problem. It can be readily understood how the direction of the cleavage has been determined by the shape of the internal core of the cone or ridge, and "why there should be such prevalent relation between the strike and the cleavage." The "irregular disposition of cleavage" seems to be exactly what Prof. Geikie would have expected the results to have been from the shear movement theory. No "distortion of fossils" show the "amount of shear," but the "cone-in-cone" structure probably does indicate it, and it is measured by the length of the columnar marking on the cleavage plane. At the Wabash Cone the shear has appearently not been more than four inches, quite enough to disturb the mass of stone and continue the chemical action which obliterated the original partings between the strata. The cleavage planes once started in the top member of the exposure, by unequal stress on the strata, would be continued downward at the same angle through the limestone and shale beds, the shear movement gradually diminishing until the equilibrium was again restored. The equilibrium would be restored on the level in which the density of the strata became uniform on a horizontal plane, and hence the downward changes have been frequently arrested above and never reach below the top of the hydraulic limestone beds.

Identical movements and changes were in operation during the formation of the cone south of Wabash, where the columnar structure of the stone is apparent; and it is probable that similar causes were active at the Lagro and Shultz cones, which, if opened to view, as the former have been, would reveal the same internal results of the shear movement. At Rockyway Falls quite an amount of quarrying has been done, but it does not show the columnar structure or other marked evidence of shear. Here, at the Narrows, the Watson Briggs Ravine, the Stanffer Farm, and at many other places the movement was very much limited, but was sufficient to account for the chemical changes and cleavage. In these outcrops the laminated shale only occurs on one side of the exposure and the direction of the movement is indicated by the cleavage.

LOCAL DETAILS.

Just north of the Wabash Railroad, between Charley Creek and Thorn Street in Wabash City, is an exposure of picket rock that is about seven hundred feet long and rises from ten to fifteen feet above

the level of the railroad track. Approached from the north the outcrop presents a gentle swell across the creek bottom, with stone sticking here and there above the surface. The railroad front is more abrupt, but is generally covered with soil. In color, obscure cleavage, crystalline structure and fossiliferous remains, it closely resembles the equivalent stone at Hanging Rock. Less than three hundred feet west of where the picket rocks are seen in the angle formed by the railroad and the east bank of Charley Creek, the following sections forty feet apart were made, the first facing south and the other facing west:

SECTION ON RAILROAD NEAR CHARLEY CREEK.

Slope	6 ft. 0 in.
Thin bedded, cherty limestone	4 ft. 0 in.
Buff laminated shale	2 ft. 0 in.
Shale	2 ft. 0 in.
Thin bedded cherty limestone	1 ft. 3 in.
Total	15 ft. 3 in.

SECTION ON CHARLEY CREEK.

Cherty limestone	5 ft. 0 in.
Thin bedded, shaley limestone	6 ft. 0 in.
Buff, heavy bedded, quarry stone, evenly stratified	3 ft. 0 in.
Heavy bedded, irregularly stratified, blue hydraulic limestone	1 ft. 9 in.
To bed of creek	14 ft. 0 in.
Total	29 ft. 9 in.

These sections show with what rapidity the character of the stone changes in the vicinity of the picket rocks, and the irregular bedding and hydraulic stone indicate the kind of stratification and stone likely to be found under them. The floor of the quarry is crossed by an anticlinal swell or hummock, which seems to be the west end of a ridge that increases in force, and extends east parallel with the center of the picket rock exposure. The laminated shale shows in the east bank of the creek near the quarry, and gradually passes beneath the channel as the creek bed rises toward the table-lands back of the river.

Across Charley Creek, west of the last section, the following measurements were made:

SECTION WEST OF CHARLEY CREEK.

Soil	1 ft. 6 in.
Thin bedded limestone	5 ft. 0 in.
Shale	2 ft. 0 in.
Thin bedded flag	1 ft. 5 in.
Shale	2 ft. 0 in.
Total	11 ft. 11 in.

SECTION AT THE WEST END OF THE BRIDGE OVER CHARLEY CREEK.

Thin, irregularly bedded quarry stone, somewhat cherty, lower strata, fair flagging	10 feet.
Buff laminated shale	18 feet.
Total	28 feet.

All the quarry stone strata of the Charley Creek quarries are thin, the best beds yielding fair flagging, subfoundation stone and rubble. It will be noticed at the bridge section, and in passing up the creek that the intercallated shale strata disappear, and the texture of the stone becomes more uniform.

East of Wabash in the triangle formed by the Wabash Railroad crossing the track of the Cincinnati, Wabash & Michigan Railway, where the former road cuts through the quarry stone strata, and into the laminated shale beds, the following section was made on the north side of the cut:

QUARRY EAST OF WABASH.

Soil	1 ft.	6 in.
Thin bedded limestone	1 ft.	0 in.
Thin cherty limestone	1 ft.	6 in.
Flagging from one to three inches thick	1 ft.	5 in.
Laminated shale to level of railroad track	12 ft.	0 in.
Total	17 ft.	5 in.

Quite an amount of work has been done in this quarry, and as the strata are thin, the product is handled without derricks. The high banks of the cut furnish very favorable facilities for loading the output on the cars.

Farther east, and more nearly on the line of the Cincinnati, Wabash & Michigan Railway than the last section, is the

PHILLIP HIPPSKIND QUARRY.

Soil	6 feet.
Buff, irregularly bedded quarry stone, strata from four to eight inches thick	8 feet
Total	14 feet.

This quarry is connected with the main line of the C., W. & M. Railway by a switch and is easily worked. The thicker strata furnish fair building stone that finds a ready market for local use. In the vicinity of these quarries the denuding forces which have formed the Wabash Valley have removed nearly all the upper cherty members of the quarry stone beds, and hence the quarrymen have but little stripping to do to get at the lower eight or ten feet of good stone.

DAVID RIDGEWAY'S QUARRY, SOUTH WABASH.

Soil and slope	4 ft.	0 in.
Stratified cherty limestone		6 in.
Cherty limestone	1 ft.	0 in.
Thin bedded, cherty limestone	5 ft.	7 in.
Shale		3 in.
Shale and limestone	1 ft.	0 in.
Even bedded flagging	2 ft.	8 in.
Total	15 ft.	0 in.

This quarry is located in the top of the river bluff, at the south end of the iron wagon bridge, sixty feet above low water. Here and elsewhere in South Wabash the chert is found in nodules and narrow, thin plates in the center of a limestone stratum, or in thin layers held together by a slight matrix of limestone. By the occurrence of a thicker stratum of shale than that usually seen between the strata, the thin layers are collected into groups on the face of the exposure. These groups are used in making the subdivisions of the sections, and the first one in this quarry is represented by the six inches of stratified cherty limestone. The beds containing a large per cent. of chert are worthless, and increase the expense of stripping down to the merchantable stone. Vertical seams occur thirty feet apart and run west, ten degrees south, and at right angles. The bedding of the shale underlying the section is very irregular, with the dip at all angles, from nothing up to seventy degrees, and in all directions. It is probable that in part the irregularity has been increased by the displacement of the strata from their original plane in the bluff. Some of the top shale are very earthy and friable. Near the level of the bridge the bedding becomes regular and assumes the character of hydraulic limestone.

SCHOULER HAFF'S QUARRY.

West End of South Wabash.

Soil		
Cherty limestone in thin even bedded strata, top of the quarry stone formation	6 ft.	0 in.
Even bedded limestone	1 ft.	0 in.
Chert		1 in.
Thin flagging	4 ft.	0 in.
Chert		2 in.
Flagging	2 ft.	0 in.
Chert		1 in.
Flagging	1 ft.	8 in.
Chert		1 in.
Flagging and dimension stone	4 ft.	0 in.
Total	19 ft.	1 in.

There is a number of other quarries besides those of Thomas Bridges, David Ridgway, Schouler Haff and Jacob Lambert, but none of them have been worked sufficiently to show the whole of the formation down to the laminated shale. All over South Wabash, on back lots and down crooked alleys, are piles of thin flagging taken from the surface. On the main street of the town was seen a front yard from which the owner had removed a quantity of stone and left his residence high and dry. As there is very little stripping to be done in developing one of these surface quarries, they can be worked at a good profit when there is a demand for light stone. As an evidence of ease and profit at which these quarries can be worked, it is told that the contractor who laid the foundation of the Presbyterian Church in Wabash City realized enough from the stone sold from the building site to pay his bill.

The South Wabash flagging, when carefully quarried, comes up in large pieces that have a beautiful smooth surface. The mode of quarrying varies with the use to which the product is to be applied. Where it is wanted for rubble and wall work light blasts are put in a few inches back from the face of the exposure and the front loosened, but not thrown down. Blasts are not admissable in a flagging quarry, but as the bedding is very loose the stones are easily removed and readily cut to the required dimensions. Vertical seams obviate the use of a channeler and keep the face of the wall perpendicular.

To the unaided eye the strata in these quarries appear to be horizontal, but when tested with the clinometer show a slight dip to the southwest. The vertical seams of the quarry stone in the vicinity of Wabash all have much the same characters, and generally cross the bedding at nearly right angles. In no case where removed from the edge of the bluffs do they show evidence that they have very great vertical range or are the result of upheaval. In South Wabash no evidence was seen to indicate that the same penetrate the laminated shale.

WILLIAM MOUELERING'S QUARRY.

Section 17, *Township* 27, *Range* 5, *East.*

Soil	1 ft. 6 in.
Thin bedded, gray, cherty limestone	1 ft. 3 in.
Clay parting	2 in.
Thin bedded, cherty, gray limestone	4 ft. 6 in.
Thin bedded, gray, good quarrystone	4 ft. 0 in.
Soft buff stone, splitting into shapeless masses, worthless	1 ft. 10 in.
Thin gray limestone	3 in.
Good buff quarry rock	3 in.
Good buff quarry rock	5 in.
Good buff quarry rock	3 in.
Good buff quarry rock	7 in.
Good buff quarry rock	3 in.

Good buft quarry rock	5 in.
Good buff quarry rock	4 in.
Good buff quarry rock	6 in.
Good buff quarry rock	10 in.
Heavy bedded buff quarry stone.	1 ft. 4 in.
Heavy bedded buff quarry stone.	1 ft. 2 in.
Heavy bedded buff quarry stone.	1 ft. 0 in.
Heavy bedded buff quarry stone.	7 in.
Heavy bedded buff quarry stone.	9 in.
Heavy bedded buff quarry stone.	1 ft. 2 in.
Shale and cement rock to the river bottom	18 ft. 0 in.
Total	41 ft. 4 in.

This quarry is extensively worked, and the output all shipped to Ft. Wayne. It is connected with the main line of the Wabash Railroad by a switch, and the stone handled with derricks and other labor-saving appliances.

SECTION NEAR THE MOUTH OF HELM'S CREEK.

Two Miles West of Wabash.

Soil	1 ft. 6 in.
Cherty limestone	2 ft. 8 in.
Thin bedded gray limestone	1 ft. 10 in.
Thin bedded buff limestone	1 ft. 5 in.
Thin bedded gray limestone	8 in.
Clay parting	1 in.
Thin bedded gray limestone	1 ft. 9 in.
Clay parting	1 in.
Thin bedded gray limestone	1 ft. 5 in.
Gray limestone	4 in.
Gray limestone	8 in.
Gray limestone	6 in.
Gray limestone	3 in.
Clay parting	3 in.
Thin bedded buff limestone, passing into buff shale	1 ft. 6 in.
Buff shale (laminated)	6 ft. 0 in.
Blue cement stone, with conchoidal fracture, to the bottom of the ravine	22 ft. 0 in.
Total	43 ft. 1 in.

The lower member of this section has hydraulic properties, but to make good cement needs an addition of lime, which can be obtained by burning the thin bedded strata of the overlying quarry stone formation. It is very probable a paying industry could be established here. The land adjoins the Wabash Railroad and a spur could be run to kilns so that the product could be handled expeditiously and cheaply.

In the bluff in the north part of Rich Valley there is a mass of apparently tilted buff limestone. Passing over the bluff the stone is seen

dipping to the north, and on down the road a small stream is encountered in the bottom of which the same buff material is regularly stratified in a horizontal position. Three hundred yards east of the apparently upthrust bluff, in the north part of Rich Valley, the following section was made on the farm of William Jackson:

SECTION NEAR RICH VALLEY.

Soil	1 ft.	0 in.
Thin cherty limestone	8 ft.	0 in.
Buff limestone		6 in.
Buff limestone		8 in.
Buff limestone		6 in.
Total	10 ft.	8 in.

This stone is approximately horizontal and is a continuation of the horizontal buff stone underlying the "tilted" material in the bluff.

In a cut on the Wabash Railroad, one mile west of Rich Valley, and one-eighth of a mile east of the county line, the following section was measured:

SECTION WEST OF RICH VALLEY.

Soil	1 ft.	0 in.
Chert stratum	2 ft.	2 in.
Cherty limestone	3 ft.	0 in.
Shale filled with cherty concretions	9 ft.	0 in.
Total	15 ft.	2 in.

A short distance south of this, in the bank of the Wabash and Erie Canal, at an abandoned quarry the same formation, but of a harder quality, outcrops, and like that of the section is useless except for macadamizing.

SECTION ON BURR CREEK.

South Part of Reservation 16, *Near the Reservation Line.*

Slope and thin nodular shale	6 feet.
Argillaceous stone in thick beds, stratification not well defined	8 feet.
Shale and covered space	3 feet.
Hydraulic limestone	7 feet.
Total	24 feet.

But little work has been done at this place, not enough to clearly show the relation of strata, and the indications are not favorable that it will yield good quarry stone.

ROSS RUN QUARRY NO. 1, RESERVATION 14.

Soil	2 feet.
Stratified limestone, strata ranging from 1 to 8 inches thick, some of them cherty	15 feet.
Blue hydraulic stone in beds from 2 to 20 inches thick, bedding uneven	8 feet.
Total	25 feet.

In the middle member of the section fifty-nine strata were counted, making the average thickness of the layers more than three inches. Vertical seams are so numerous as to destroy the value of the stone for flagging.

ROSS RUN QUARRY No. 2.

Even bedded, horizontal quarry stone	3 ft.	0 in.
Shale stratum		5 in.
Thin bedded gray stone		4 in.
Fair heavy flagging		10 in.
Fair heavy flagging		9 in.
Fair heavy flagging		6 in.
Fair heavy flagging		7 in.
Covered slope to bottom of the run	4 ft.	0 in.
Total	10 ft.	5 in.

This section was taken above No. 1, and about one hundred and fifty feet below the creek falls, where the quarry stone has four feet of hydraulic limestone underlying it. The top member of No. 2 is made up of fourteen layers, some of them being very cherty, while others can be used for light work. These quarries are favorably located and can be easily developed.

MARTIN WILLIS' QUARRY.

South of Lagro, on the Township Line Pike.

Soil and gravel	5 ft.	6 in.
Thin, irregularly-bedded, shaley limestone	4 ft.	0 in.
Thin-bedded buff limestone, in layers ranging from 1 to 6 inches thick, texture coarse and surface somewhat rough	5 ft.	4 in.
Total	14 ft.	10 in.

This quarry has not been opened down to the underlying laminated shale, and it is probable that thicker and more valuable stone would be found were this done. At all other quarries the best quality and thickest stone has been found at the bottom of the quarry stone formation. What stone has been removed has been sold at the quarry for local use. On the east side of the quarry is a ravine running north that presents some of the characters of a glacial groove. The ravine or groove is now nearly filled with gravel, but where the stone covering the bottom has been uncovered it presents a smooth, hard surface, very different from that of the recently exposed strata. This peculiar appearance may be the result of either glacial action or of running water and exposure to atmospheric influences. The peculiar relations of the quarry stone to the laminated shale, and the evidence of a trough-like structure in this quarry, have been already described.

SECTION IN THE WEST BANK OF THE SALAMONIE RIVER.

Below the Dam and One-Half Mile West of Hanging Rock.

Soil	8 ft. 0 in.
Yellow and gray shale	4 ft. 0 in.
Brown arenaceous limestone	2 in.
Yellow-gray shale	5 ft. 0 in.
Heavy-bedded, blue cement stone	1 ft. 2 in.
Shale parting	2 in.
Heavy-bedded, blue cement stone	1 ft. 10 in.
Blue cement stone, with conchoidal fracture, to the water's edge	3 ft. 0 in.
Total	23 ft. 4 in.

The stratified material here dips slightly to the north and seems to occupy the same relative position as the hydraulic limestone seen under Hanging Rock at the north end of the wagon bridge over the Wabash at Lagro, above the dam in the west bank of the Salamonie at Dora, and New Holland. Stone from equivalent beds was used in the locks of the Wabash & Erie Canal in the vicinity of Lagro, and came from an abandoned quarry near the foot of the bluff on the west side of the river.

SECTION NEAR BELDEN.

Well on the Farm of Masso Jackson.

Soil	1 foot.
Limestone	15 feet.
Chert	9 feet.
Total	25 feet.

The chert of this section was so hard that the well-diggers abandoned it before finding water. They say the stone was very irregularly stratified and dipped in all directions.

QUARRY OF ASA KINLEY.

On Rush Creek, Near New Holland.

Soil	5 ft. 0 in.
Blue even-bedded flagging	6 in.
Buff thin-bedded flagging	3 in.
Buff thin-bedded flagging	3 in.
Heavy-bedded blue limestone to bed of creek	1 ft. 6 in.
Total	7 ft. 6 in.

Across the creek the following section is shown:

Soil	1 ft. 6 in.
Yellow, rotten shale	5 ft. 0 in.
Heavy-bedded blue limestone, hydraulic cement rock to water's edge	12 ft. 0 in.
Total	18 ft. 6 in.

This last overlies the quarry rock of the preceding section. All the stone quarried here seems to have hydraulic properties, and would probably make good cement if burned and mixed with the proper proportions of lime and sand.

The abutments of the bridges across Rush Creek above and below New Holland are built of stone from the Kinley quarry, and it bids fair to be very durable. Its color and smooth fracture give it a remarkably handsome appearance in the wall.

SECTION AT THE MOUTH OF JOSINA CREEK.

Section 32, Town. 26, Range 7 East.

Soil	7 ft. 0 in.
Indurated yellow shale	1 ft. 10 in.
Blue heavy-bedded hydraulic quarry rock to the water's edge	2 ft. 4 in.
Total	11 ft. 2 in.

The last member is a medium quality building stone if quarried and allowed to season before exposure to frost. This outcrop dips rather rapidly and disappears just where the creek empties into the Mississinewa River.

It was near here that the memorable battle in which Lieut. Waltz, for which Waltz Township is named, was killed on the morning of December 18, 1812.

SECTION AT LEONARD HYMAN'S QUARRY.

On the Mississinewa River in Waltz Township.

Soil and covered slope	3 ft. 0 in.
Thin bedded buff limestone, quarry stone formation	4 ft. 4 in.
Shale	9 in.
Thin bedded buff limestone	2 ft. 10 in.
Thin, even bedded blue limestone	7 ft. 0 in.
Total	17 ft. 11 in.

The limestone strata here dip rapidly to the southwest at an angle of eleven degrees. This dip is probably due to the rocks having been deposited in a trough-like depression or channel in the underlying shale, as the strata a short distance west, and resting on a continuation of the same shale, are approximately horizontal. The shale underlying these apparently upheaved rocks is horizontal, and the same is true of all the equivalent beds seen in this vicinity. The upper part of the shale is buff colored and the lower part a blue-gray.

The following fossils were seen: *Atrypa reticularis, Orthis biloba, Zaphrentis*, sp.(?), *Halysites catenulatus*, young of *Ambonychia, acutirostra, Lituites marshi, Calymene niagarensis, Dictyonema*, sp.(?), *Tenestella parvulipora, Orthis elegantula, Meristina nitida, Favosites niagarensis, Spirifera crispa, Strophomena rhomboidalis, Lichenalia concentrica*, and crinoid stems.

SECTION ON THE MISSISSINEWA RIVER.

Three hundred yards below the last section.

Thin bedded, gray, shelly limestone, full of crinoid remains	4 ft. 4 in.
Rotten, buff limestone	1 ft. 8 in.
Thin bedded, gray limestone, largely composed of comminuted crinoids	8 ft. 0 in.
Cherty limestone	9 in.
Chert band	4½ in.
Cherty limestone	2 in.
Chert band	5 in.
Thin, gray laminated limestone	6 in.
Chert band	1 in.
Gray limestone	4 in.
Chert band	2 in.
Thin bedded, gray limestone, with *Pisocrinus gemmeformis* and *Pisocrinus gorbyi*	8½ in.
Cherty limestone	1 ft. 3 in.
Shale, with *Zaphrentis celator*, *Cladopora reticulata*, and *Lichenalia concentrica*	1 in.
Heavy bedded, blue limestone; good quarry rock	1 ft. 0 in.
Heavy bedded, blue limestone; good quarry rock	1 ft. 0 in.
Shale at the water's edge	8 ft. 0 in.
Total	28 ft 10 in.

PHILLIP DAVIS' QUARRY ON THE MISSISSINEWA RIVER.

Section 27, Town. 26, Range 7 East.

Soil and slope	4 ft. 0 in.
Thin bedded, buff limestone	16 ft. 0 in.
Heavy bedded, blue limestone	1 ft. 0 in.
Heavy bedded, buff limestone	10 in.
Buff shale to bed of river	17 ft. 0 in.
Total	38 ft. 10 in.

This quarry furnishes a good, durable building stone for light structures, but is entirely too thin bedded for heavy work. An occasional piece of flagging is gotten out, but is very rough owing to the layers coalescing. The strata are approximately horizontal here, while at other places there is a rapid dip, caused by intercallated, wedge shaped masses of stone.

Formerly this stone was burned for lime, making a dark, "hot" lime, for which there was a limited local demand, but after the railroads became so numerous it was unable to compete with the product of the modern kilns.

JACOB ULLERY'S QUARRY NEAR SOMERSET.

Southeast Quarter of Northeast Quarter of Section 32, Town. 26, Range 6 East.

Soil	6 ft.	0 in.
Thin bedded, gray limestone	1 ft.	6 in.
Buff shale		10 in.
Chert		1 in.
Thin bedded limestone		11 in.
Cherty limestone	1 ft.	0 in.
Shale and chert		7 in.
Thin bedded, gray limestone	1 ft.	7 in.
Gray limestone, flagging		6 in.
Flagging, surface smooth		3 in.
Flagging, surface smooth		4 in.
Flagging, surface smooth		4 in.
Thin bedded gray limestone		6 in.
Heavy bedded gray limestone	1 ft.	6 in.
Heavy bedded gray limestone		6 in.
Heavy bedded dimension stone	1 ft.	6 in.
Shale		2 in.
Heavy bedded gray limestone	1 ft.	2 in.
Shale		5 in.
Heavy bedded gray dimension stone		10 in.
Heavy bedded gray dimension stone	1 ft.	0 in.
Heavy bedded gray dimension stone	1 ft.	5 in.
Total	24 ft.	11 in.

The heavier bedded members of this section contain excellent material for foundations, bridge abutments and piers. Specimens of *Pisocrinus gorbyi*, *Pisocrinus gemmiformis*, *Orthoceras crebescens* and *orthis elegantula* were seen.

Across the ravine from the preceding the following section was made:

Soil and slope not measured.		
Cherty limestone	2 ft.	2 in.
Shale		2 in.
Thin bedded limestone		9 in.
Heavy bedded limestone		10 in.
Heavy bedded dimension stone	1 ft.	0 in.
Heavy bedded dimension stone	1 ft.	2 in.
Heavy bedded dimension stone		6 in.
Heavy bedded dimension stone	1 ft.	11 in.
Heavy bedded dimension stone		6 in.
Heavy bedded dimension stone	1 ft.	7 in.
Shale		2 in.
Heavy bedded buff dimension stone	1 ft.	3 in.
Heavy bedded buff dimension stone	1 ft.	10 in.
Heavy bedded buff dimension stone	1 ft.	4 in.
Total	15 ft.	2 in.

The stone of this section has apparently been deposited in a trough of the underlying shale that is seen a few rods farther down the ravine, occupying a higher position than the bottom of the quarry. The strata are approximately horizontal, and no other explanation of its relations to the shale seem tenable. This is a splendid quality of stone, and, with railroad facilities, would be a fortune to the owner.

S. B. SHULTZ'S QUARRY, ONE MILE WEST OF SOMERSET.

Sec. 29, *Town.* 26, *Range* 6, *East.*

Soil	3 ft. 0 in.
Thin bedded, cherty, buff limestone	7 ft. 0 in.
Buff limestone, surface smooth	6 in.
Buff limestone, surface smooth	6 in.
Buff limestone, surface smooth	6 in.
Buff limestone, surface smooth	6 in.
Buff limestone, surface smooth	6 in.
Buff limestone, surface smooth	8 in.
Buff limestone, surface smooth	8 in.
Buff limestone, surface smooth	6 in.
Buff limestone, surface smooth	4 in.
Buff limestone, surface smooth	4 in.
Buff limestone, surface smooth	7 in.
Buff limestone, surface smooth	4 in.
Buff limestone, surface smooth	5 in.
Buff limestone, surface smooth	4 in.
Buff limestone, surface smooth	4 in.
Buff limestone	10 in.
Buff limestone	1 ft. 6 in.
Total	19 ft. 4 in.

This is a very excellent building stone, the iron in it being thoroughly oxydized, it is not affected by the changes of temperature.

None of the sections given on the Mississinewa River, except that taken at the mouth of Josina Creek, have vertical range sufficient to include the hydraulic limestone. It is exposed, however, at many other points in the bottom of the deep ravines, and, wherever seen, presents much the same characters as the equivalent beds on the Salamonie and Wabash rivers.

[redacted] AGE.

QUATERNARY

DRIFT PERIOD.

In sinking gas wells, at Lafontaine, rock was struck by the drillers of the well near the flour mill at a depth of 300 feet, at 180 feet one-third of a mile south, and at 167 feet one-half of a mile south. In boring for water on the farm of Mr. William Kester, in Chester Township, rock was encountered at 181 feet from the surface, and in the well of Mr. Lat.

Waggoner, of Liberty Township, at 96 feet. The average of these wells is 185 feet. The 274 feet of Drift passed through in the gas well at North Manchester, and the 120 feet at Somerset, are not included in the calculation, as they are both in river valleys, where it is probable the original deposit has been very much modified since the climax of the Glacial Epoch. It is probable the 185 feet once very nearly represented the original average thickness of the deposit as it lay spread over the county. All measurements under this indicate the amount of material which has been swept away by the floods, and dropped elsewhere in the valleys and deltas.

Unmodified Drift is everywhere made up of blue glacial clay, yellow clay, sand, gravel and bowlders. Generally the materials are roughly arranged in strata, but it is only the glacial and yellow clays which seem to occupy a special place in a systematic classification. The glacial clay is always at, or near, the bottom of the formation, and the yellow clay at the top. Both were present in all sections of unmodified Drift seen in the county, but it is not to be understood that this is stated as a general rule applicable to other parts of the State.

The yellow clay ranges in thickness from 7 to 25 feet, the latter being the measurement made at Lafontaine, a point well removed from modifying influences. The blue clay stratum is very variable in thickness, and ranges from 9 to 140 feet. The glacial clay is frequently divided into layers by one or more strata of sand or gravel, or of sand and gravel, which are continuous for many feet, and the whole formation may rest on gravel. The sand and gravel beds in the yellow clay are much more limited in extent, and are usually found in lenticular masses. Along the rivers and creeks, where the clay has been dissolved out by the water, the sand and gravel have been left behind in beds and mounds which show their origin by their internal structure.

Bowlders of large size are infrequent, except in the valleys. Perhaps the greater part of those exposed are to be found in Pawpaw Township, where the denuding force which formed the Wabash Valley has acted over a wider range of territory than usual. All seen were representations of primitive rock; the most common being varieties of gniess, greenstone, mica schist, granite and hornblende. In weight they vary from a few pounds to seven tons. They do not seem to be peculiar to any stratum, and are found in greater quantity at certain places on the surface because the clay in which they were originally imbeded has been washed away.

No moraines or kames were seen, but the surface of the yellow clay is dotted with slight mounds containing an increased quantity of sand and fine gravel. Surface points of interest that should have more careful study than we were able to give them are the hills and gravel mounds of Pleasant Township. To properly investigate their relations

to the other members of the drift, they should be examined in connection with similar deposits in Fulton County, of which they seem to be the eastern prolongation.

The muck beds of the same vicinity are very remarkable for their depth and are doubtless the result of vegetable decay in ancient glacier channels where it has accumulated since the close of the Glacier Epoch. Because of its antiseptic properties it often contains bones that would have decayed long ago in ordinary clay, and if the muck is of later origin than the drift, it is reasonable to suppose that the bones found in it are the remains of animals which were not yet extinct.

Marl is found in the northwest part of the county lying several feet above the lakes and ponds. The vegetation growing over this region is peculiar, and it was known in the early settlement of the country as the "barrens;" but the land was anything but barren. Mr. R. G. Arnold, who lives in this neighborhood, says that when he settled there fifty years ago he cut a hickory tree for a barn timber that squared six inches in diameter at the top, and was not more than ten inches in diameter at the stump.

RECENT PERIOD.

Along the water courses alluvial deposits of dark clay and sand occur which have wholly lost all indication of their drift origin. In the river banks it has a depth of twenty-five feet, and is subject to constant changes near the channel. The alluvium of the uplands is represented by the black soil in the surface depressions. In the swamps it frequently reaches quite a depth. The materials composing that in the valleys and swamps are the same; but they slightly vary in proportion, the latter often containing more organic matter.

FOSSIL BONES OF THE DRIFT.

Mammoth bones, *Elephas primigenius*, were found several years ago in Pleasant Township, where some men were throwing up an embankment for a bridge across Silver Creek, under about five feet of muck. Some of these bones are said to be in the Wabash College, at Crawfordsville. On the farm of Mr. Jesse L. Williams, section 8, township 29, range 5, east, two miles west of Laketon, near the bank of Silver Creek, in 1872, nearly a complete skeleton of a *Mastodon americanus* was found by Mr. Jacob Steveson while digging a ditch at the side of the road. Considerable litigation was indulged in over the ownership, but the matter was finally settled, and they were taken to Fort Wayne and put on exhibition. The head and antlers of an elk were unearthed by Mr. Longnecer in a swamp he was draining near the west county line. The antlers measured eight feet from tip to tip.

Three miles due east of North Manchester on the northwest quarter of the northeast quarter of section 1, township 29, range 7, east, Mr. Simon S. Morrow discovered a jawbone with two teeth in it. In a communication to the *Toledo Blade*, Mr. Morrow says: "One of the teeth measured $7\frac{3}{4}$ inches from back to front by 4 inches broad, and weighed $6\frac{1}{2}$ pounds. It has three roots which measured from 5 to 6 inches long, but the points were gone." The other tooth was smaller and more decayed. He says they were found beneath $2\frac{1}{2}$ feet of "solid blue-clay, where a hickory-elm eighteen inches over had blown out of root."

Mr. John H. Pefley, east half of the southwest quarter of section 18, township 27, range 8, east, near Dora, found two large teeth on his farm, one of which we saw, and identified as that of a fossil elephant, *Elephas primigenius*.

On the farm of Mr. William Ruckle, three and one-half miles north of Roann, Mr. Rantz, in 1882, while digging a ditch, unearthed the antlers and part of the skeleton of a deer, *Cervus virginianus*, at a depth of nine feet.

SECTION OF WELL ON THE FARM OF JOHN H. PEFLEY.

East Half of Southwest Quarter of Section 18, *Town.* 27, *Range* 8 *East.*

Soil and yellow clay	7 ft. 0 in.
Blue clay, sand and gravel	24 ft. 0 in.
Blue hardpan clay	1 ft. 6 in.
Dry sand	8 ft. 0 in.
Blue hardpan clay, sand and gravel	12 ft. 0 in.
Blue hardpan clay, not penetrated by sand, water-bearing	9 ft. 6 in.
Total	62 ft. 0 in.

This farm is on the bluff northwest of Dora. The measurements were furnished by the proprietor, an intelligent observer, who has paid considerable attention to Geology, and may be accepted as correct and typical of the Drift deposits in all things except thickness. The three strata of hardpan clay and the sand and gravel found between them are probably the direct results of glacial action as the ice sheet advanced from north to south, while the upper members, composed of plastic blue and yellow clay, were formed as the glacier receded.

SECTION OF SAND BANK ON THE FARM OF BEN WOLFE.

West Side of Rush Creek.

Soil and gravel	3 feet.
Dark, earthy sand	10 feet.
Cavities in loose sand	2 feet.
Dark, earthy sand	3 feet.
Irregularly-bedded gravel	5 feet.
Fine sand, with bands of sand and small gravel	20 feet.
Total	43 feet.

The strata of this section vary in thickness and somewhat change in dip. Especially is this true of the lower twenty-five feet, which clearly shows in the stratification the assorting action of water, and fairly well represents the modified Drift of the Terrace Epoch. The sand here is an excellent material for building and plastering purposes, and is extensively used in the neighborhood. Gravel beds are frequent in the valley of the creek, and are fairly represented by the following measurements:

SECTION OF GRAVEL BED ON THE FARM OF ASA KINLEY.

South of New Holland.

Soil	6 in.
Yellow gravel	2 ft. 0 in.
Coarse, gray gravel	10 ft. 0 in.
Total	12 ft. 6 in.

Between this exposure and Holland twenty feet of sand was seen occupying a higher level than these beds of gravel.

SECTION OF WELL ON THE FARM OF JESSE D. SCOTT.

Liberty Township.

Soil	1 foot.
Yellow clay	5 feet.
Blue clay	3 feet.
Fine, blue water-bearing sand	4 feet.
Total	13 feet.

This well furnishes an abundance of good, cold water. In the field about fifteen rods northwest there is another well that passes through the following strata:

Soil	2 ft. 6 in.
Yellow clay	9 ft. 0 in.
Gravel, first water-bearing stratum	1 ft. 0 in.
Total	12 ft. 6 in.

Blue clay not measured.

In 1886 this well failed and the wall was taken out so as to remove the gravel. Since then it has furnished an abundance of water. In wells of this character it is probable that the whole of the water-bearing stratum of sand and gravel is saturated and not traversed by veins. Such wells are very liable to become contaminated from surface drainage.

GENERAL SECTION OF WELLS IN LAFONTAINE.

Soil	1 ft. 6 in.
Gravel	20 ft. 0 in.
Total	21 ft. 6 in.

East of the creek adjoining the town the wells pass through—

Soil	4 feet.
Yellow clay	25 feet.
Gravel, water-bearing	2 feet.
Total	31 feet.

SECTION OF GRAVEL BANK ON THE MISSISSINEWA RIVER.

Liberty Township.

Soil	2 feet.
Good, coarse gravel to the water's edge	30 feet.
Total	32 feet.

There is an immense amount of first-class road gravel in this part of the township, and leaves its citizens with no better excuse for bad roads than the simple plea that they have not put it where it will do the most good.

WELL ON THE FARM OF MR. KNEE.

Liberty Township.

Soil	1 ft. 6 in.
Gray clay	18 ft. 0 in.
Total	33 ft. 6 in.

Water was found in this well, but the gravel clogged the pump and rendered it useless.

WELL ON THE FARM OF ALEX. DAVIS.

Section 27, Town. 26, Range 6 East, Waltz Township.

Soil	2 ft.
Stone and shale	40 ft.

Good water was found in the shale, and wells put down to the same geological level should be safe from surface contamination.

GRAVEL BANK NEAR THE OGAN GRAVEYARD.

N. W. ¼ of S. W. ¼ of Sec. 23, Township 26, Range 6 East.

Soil	1 ft. 6 in.
Good, coarse gravel to level of the pike	10 ft. 0 in.
Total	11 ft. 6 in.

This exposure is on the Vernon Pike, one mile north of the Mississinewa River. It furnishes good road making material, and was used as far as it was possible to mine it readily, in building the Wabash and Vernon Pike. It probably extends to a much greater depth than is here recorded, but the section shows all that is exposed in the cut, where the road is graded through the hill.

GRAVEL PIT ON THE FARM OF JOHN NEFF.

Section 36, Township 26, Range 6 East, Waltz Township.

Soil	3 ft.
Coarse, gray gravel	10 ft.
Total	13 ft.

This pit has been worked extensively for local use, and makes a good road.

WELL ON THE FARM OF JOHN NEFF.

Black soil	1 ft. 6 in.
Yellow clay	3 ft. 0 in.
Gravel, lower part water bearing	21 ft. 0 in.
Total	25 ft. 6 in.

In the gravel members of this section layers and lens shaped masses of fine yellow sand occur. Occasionally the masses are white, and probably indicate that the surface Drift of this region was deposited from the water coming from the foot of a glacier as it receded north.

DRIFT ON THE FARM OF JOHN GARST.

S. W. Qr. of Section 28, Township 26, Range 6 East.

Soil	4 ft.
Coarse, gray gravel	12 ft.
Blue clay	15 ft.
Total	31 ft.

A short distance east of this and north of the road the following section was measured:

Soil	3 ft.
Coarse, gray gravel, good road material	15 ft.
Total	18 ft.

A greater number of sections might have been taken in this, Waltz Township, but they would have been essentially a repetition of those already given. There is an unlimited amount of good road gravel, easy of access in the township; enough, in fact, to gravel all the roads in the county.

AVERAGE OF WELLS IN RICH VALLEY.

Soil	1 ft. 6 in.
Yellow sand	9 ft. 0 in.
Gravel, water bearing	2 ft. 0 in.
Total	12 ft. 6 in.

An abundant supply of water is found wherever the gravel is reached by boring or digging.

WELL ON THE FARM OF WILLIAM JACKSON.

Near Rich Valley.

Soil	1 ft. 6 in.
Yellow clay	7 ft. 0 in.
Yellow sand	4 ft. 0 in.
Blue clay	3 ft. 0 in.
Coarse, gray gravel	6 ft. 0 in.
Impression cemented sheet of black gravel	3 in.
Total	21 ft. 9 in.

After passing through the last member of the section an unlimited amount of water was found that rose to the top of the cemented layer and flowed off through the overlying gravel.

SECTION OF GRAVEL ON THE FARM OF WILLIAM JACKSON.

Sec. 13, *Town.* 27, *Range* 5, *East.*

Soil	3 ft.
Coarse, gray sand	8 ft.
Coarse, gray gravel	30 ft.
Total	41 ft.

This gravel bed extends along the bluffs one-half mile, and contains enough material to make and keep in repair all the roads in the township for ages.

GRAVEL PIT ON THE FARM OF SAMUEL KUFFEL.

Sec. 26, *Town.* 29, *Range* 5, *East, Pawpaw Township.*

Soil	2 ft.
Coarse, gray gravel	25 ft.
Total	27 ft.

Enough material has been taken out of this pit to macadamize seven miles of township roads.

GRAVEL PIT ON THE FARM OF A. T. GIDLEY.

Sec. 36, *Town.* 29, *Range* 5, *East, Pawpaw Township.*

Soil	1 ft. 6 in.
Coarse, gray gravel	14 ft. 0 in.
Total	15 ft. 6 in.

The gravel of this section extends to a much greater depth than is here indicated, but the total thickness has not been determined. This farm lies adjacent to Eel River, in the northwest part of the township.

WELL ON THE FARM OF A. T. GIDLEY.

Sec. 2, Tp. 26, R. 5 E., Pawpaw Township.

Soil	2 ft.
Gravel and sand alternating	24 ft.
Coarse gravel, water bearing stratum	2 ft.
Total	28 ft.

Near the bottom of the well a good sized branch of a tree was found, and it is a common occurrence to find vegetable remains in the gravel at depths ranging from eighteen to thirty feet. This well is only twenty feet from a dry well, yet it furnishes an abundance of water for a stock farm. The stream encountered in digging the well filled it so rapidly that it was with difficulty it was walled. One hundred and fifty feet away a driven well was put down one hundred and five feet before finding a limited quantity of water.

WELL ON THE FARM OF R. G. ARNOLD.

S. E. Qr. Sec. 12, Tp. 29, R. 5 E., Pleasant Township.

Soil	1 ft.
Sandy loam	30 ft.
Water bearing gravel, not measured	
Total	31 ft.

The water in this well is abundant in quantity and excellent in quality.

SECTION OF WELL IN ROANN.

Corner of Chippewa and Allen Streets.

Soil	1 ft. 6 in.
Gray sand and gravel alternating	36 ft. 0 in.
Total	37 ft. 6 in.

The diggers of this well contracted to put it down forty feet, but they encountered large bowlders and were forced to suspend operations; not, however, before finding a good supply of water.

WELL ON THE PROPERTY OF J. V. BUSKIRK.

Laketon.

Soil	1 ft. 6 in.
Coarse, gray gravel	7 ft. 6 in.
Total	9 ft. 0 in.

An abundance of water was found here, and while it is used as a town well it has never been pumped dry.

WELL ON THE PROPERTY OF W. C. OGDEN.

Laketon.

Soil	3 ft.
Gravel, water bearing	10 ft.
Blue clay	6 ft.
Coarse, gray gravel, not measured	
Total	19 ft.

If the accepted theory as to the origin of typhoid fever from polluted drinking water is correct, this last well, judging from geological data, should be the safer one for household use. Experience shows that wells which stop in the first gravel are very liable to contamination, and the argument that because a well so far has been a safe one it will continue healthful is fallacious, and does not prove that the typhoid germ can not more readily find lodgment in such wells. The safe rule is to dig deep and shut out all surface water. Every property owner should be able to show a clean sanitary history of his pump along with his abstract of title.

TOWNSHIP GRAVEL PIT.

West end of town of Laketown.

Soil	2 ft. 4 in.
Coarse, gray gravel	9 ft. 0 in.
Total	11 ft. 4 in.

This pit yields an excellent road making material. The gravel is underlaid by a blue glacial clay with gravel sparingly intermixed.

WELL ON THE FARM OF RANKIN HOOVER.

S. W. Qr. Sec. 26, *Town.* 29, *Range* 7 *East, Chester Township.*

Soil	1 ft. 6 in.
Yellow clay	18 ft. 0 in.
Blue clay	140 ft. 0 in.
Water-bearing gravel	5 ft. 0 in.
Total	164 ft. 6 in.

The water stands one hundred and thirty feet deep in this well.

WELL ON THE FARM OF EDWARD ALSPAUGH.

Chester Township.

Soil	1 ft. 6 in.
Yellow clay	18 ft. 0 in.
Blue clay	140 ft. 0 in.
Fine gray sand passing into gravel	26 ft. 0 in.
Total	185 ft. 6 in.

This farm adjoins that of Mr. Rankin Hoover. Water here rises one hundred and twenty feet in the well. The surface at this well is slightly higher than at the former.

WELL ON THE FARM OF WILLIAM KESTER.

N. E. Qr. of S. E. Half of Sec. 11, Town. 29, Range 7 East, Chester Township.

Soil	1 ft. 6 in.
Yellow clay	18 ft. 0 in.
Blue clay	140 ft. 0 in.
Gray sand	21 ft. 6 in.
Gray stratified limestone	26 ft. 0 in.
Total	207 ft. 0 in.

No water was found.

WELL ON THE PROPERTY OF LEVI SNELL.

North Manchester.

Soil	2 ft. 0 in.
Coarse, gray gravel	17 ft. 0 in.
Blue clay	10 in.
Gray sand	30 ft. 0 in.
Coarse, gray gravel	4 ft. 0 in.
Total	53 ft. 10 in.

WELL ON THE PROPERTY OF E. I. TAYLOR.

North Manchester.

Soil, black muck	4 feet.
Gray sand	67 feet.
Total	71 feet.

A bed of bowlders, the size of one's fist, was encountered in sinking this well, but an abundant supply of water was found that rises one-half an inch above the ground.

The three last sections when compared with the preceding three show in a very marked manner the difference between modified and unmodified drift. The sections of modified drift at North Manchester are not only different from the others, but they differ very much among themselves.

WELL ON THE FARM OF HENRY HINKLE.

Seven Miles West of North Manchester.

Soil	1 ft. 8 in.
Black muck	108 ft. 4 in.
Coarse, gray gravel	4 ft. 0 in.
Total	114 ft. 0 in.

Water rose 101 feet. The well is put down on the highest land in the neighborhood, the drillers estimating that the surface is thirty feet above the surrounding country, and they wonder where the water comes from. The bed of muck indicates the existence of an ancient glacial channel.

WELL ON THE FARM OF NATHANIEL BANNISTER.

Lagro Township.

Soil	1 foot.
Yellow clay	9 feet.
Blue clay	68 feet.
Coarse, gray sand	6 feet.
Total	84 feet.

Water rises thirty-eight feet in this well and furnishes an abundant supply. The drillers say that wells put down in this vicinity, five miles south of Lagro, do not vary materially from that of the last section. Five miles north of Lagro, in certain neighborhoods, the wells reach the stone at seventy and seventy-five feet, especially is this true of the wells in the vicinity of the Fultz' farm.

WELL ON THE FARM OF CHRISTOPHER SPEICHER.

Lagro Township.

Soil	1 ft.	8 in.
Yellow clay	19 ft.	0 in.
Blue clay	60 ft.	0 in.
Coarse, gray gravel	4 it.	0 in.
Blue clay	65 ft.	4 in.
Gray coarse gravel	6 ft.	0 in.
Total	156 ft.	0 in.

Water stands 117 feet deep in this well. At the top of the blue clay, the drillers passed through a thin stratum of water bearing sand and they say the water invariably rises in the well to the height of the first water bearing stratum. This statement agrees with the conclusions reached by the late State Geologist, Prof. E. T. Cox, that the temperature of the water in a deep well is determined by the temperature of the first water which finds access to the bore. If the first water bearing stratum passed determines the height of the water and its temperature, the inference is plain that it will also determine its sanitary condition. Such wells are unsafe. To make them germ proof they should be tubed and packed like a gas well, and all chance of surface contamination cut off.

WELL ON THE LOT OF THE LAGRO CEMENT MANUFACTURING CO., IN LAGRO.

Soil	3 ft.
Cement rock	21 ft.
Total	24 ft.

This well and the Lagro public well, which penetrates the hydraulic limestone sixty-eight feet, show that the cement rocks are water bearing. They both furnish an abundant supply of good water.

WELL ON THE FARM OF PETER CHRISTMAN.

S. W. Qr. of Sec. 33, Town. 28, Range 7, East.

Soil and clay	6 ft.
Blue cement rock	54 ft.
Total	60 ft.

Water in abundance. This well is on the bluff, one-fourth of a mile north of the Wabash River and one mile west of Lagro.

GRAVEL PIT ON THE FARM OF MRS. RAMSEY.

Sec. 2, Town. 27, Range 7, East.

Soil	3 ft.
Good, coarse, gray gravel	15 ft.
Yellow-gray shale	18 ft.
Blue cement stone	32 ft.
Total	68 ft.

Gravel from this pit was used in building the Lagro and Township Line Pike and on the State Road, and is an excellent road making material.

WELL ON THE FARM OF JACOB THOMAS.

Liberty Township.

Soil	1 ft.
Yellow Clay	9 ft.
Blue clay	50 ft.
Coarse, gray, water bearing gravel	4 ft.
Total	64 ft.

The water here rose ten feet, and is in inexhaustable quantity.

WELL ON THE FARM OF LAT. WAGGONER.

Liberty Township.

Soil	1 ft. 0 in.
Yellow clay	9 ft. 0 in.
Blue clay	70 ft. 0 in.
Coarse, gray gravel	4 ft. 0 in.
Gray hard-pan	4 in.
Thin blue mud	8 ft. 0 in.
Fine, gray sand	3 ft. 0 in.
Gray, stratified limestone	8 in.
Total	96 ft. 0 in.

An abundance of water was found in the coarse, gray gravel, and the drillers set the pump screen on the underlying hard-pan; the water passing over it, and into the screen, washed through the hard-pan and let the

water pass down into the next stratum so as to necessitate further drilling. The drill finally passed into a crevice in the limestone that furnished an ample supply of water which rose fourteen feet in the well. The measurements and other details here given were furnished by Mr. John A. Martin, of North Manchester.

GRAVEL BED NEAR ROCKYWAY FALLS.

On the Farm of Jacob Falls, Lagro Township.

Soil and clay	5 ft.
Coarse, gray gravel, with a few medium sized bowlders scattered through it,	25 ft.
Total	30 ft.

NATURAL GAS.

A number of gas wells of average capacity have been put down in the south part of the county, in the vicinity of Lafontaine, Vernon and Somerset. Several test wells have been bored in other parts of the county, but no gas in paying quantities found north of Lafontaine. In fact, Lafontaine seems to be located on the extreme northern prolongation of the Anderson-Muncie gas field.

There are no surface indications of the existence or non-existence of gas, and those who go about the country pretending that they can tell where a successful bore may be made, are either fools or knaves. The only way in which to determine whether gas exists under a given spot or not is to put down a test well.

LAFONTAINE.

Gas Well No. 1, Near the Flour Mill.

Drift	300 ft.
Niagara limestone	225 ft.
Hudson River limestone and shale	175 ft.
Utica shale	200 ft.
Trenton limestone	23 ft.
Total depth	923 ft.
Trenton, below sea level	6 ft.

Yielding a very strong flow of gas.

In this section it will be noticed that the thickness of the Drift is given at the enormous depth of three hundred feet and the intervening strata above the Trenton at only six hundred feet. These measurements indicate the existence of a deep ravine in the upper limestone stratum.

LAFONTAINE.

Average of Five Gas Wells.

Drift	160 to 200 ft.
Niagara limestone	300 ft.
Hudson River Group limestone and shale	300 ft.
Utica shale	100 ft.
Trenton	16 to 28 ft.
Total depth	928 ft.
Altitude of the railroad station	894 ft.

SOMERSET.

Gas Well No. 1.

Drift	120 ft.
Limestone	230 ft.
Shale	60 ft.
Hudson River and Utica shale	450 ft.
Trenton	40 ft.
Total depth	900 ft.

This well is located on the farm of Edward Tucker, ten miles south of Wabash City, on the Vernon Pike, and one mile southwest of Vernon. It furnishes only a small quantity of gas, and was plugged with two plugs, one at the top and the other at the bottom.

SOMERSET.

Gas Well No. 2.

Drift	28 ft.
Limestone (Niagara?)	300 ft.
Hudson River and Utica shale	370 ft.
Trenton	30 ft.
Total depth	928 ft.

This well is on the farm of Edward Tucker, Jr., and furnishes a large quantity of gas, which is piped to Wabash.

SECTION OF SOMERSET GAS WELL.

Soil	3 ft.
Blue clay	55 ft.
Gravel	1 ft.
Limestone (Niagara?)	340 ft.
Hudson River shale	150 ft.
Red shale (Utica?)	277 ft.
Trenton	27 ft.
Total depth	853 ft.

This well was spoiled by letting it blow until salt water came in and ruined it. One hundred and twelve feet from the surface a heavy flow

of chalybeate water commenced that continued until a well on the farm of James Anderson was drilled, which, being on lower ground, drained it. Water was also found in the limestone at a depth of 485 feet. Two other wells were drilled in this field, one northeast and the other southwest, at about one-fourth of a mile distance, but no gas was found.

WABASH.

Gas Well No. 1.

Hydraulic limestone, Niagara	150 ft.
Niagara limestone	230 ft.
Shale (Hudson River?)	223 ft.
Slate (Utica?)	325 ft.
Limestone and shale, Trenton	512 ft.
Sandstone and shale	10 ft.
Total depth	1,450 ft.
From surface to Trenton limestone	925 ft.

WABASH.

Gas Well No. 2—Dr. Ford's Record.

Drift	28 ft.
Niagara	525 ft.
Hudson and Utica shale	325 ft.
Trenton	54 ft.
Total depth	932 ft.
Trenton below sea level	198 ft.
Altitude at mouth of well	680 ft.
Altitude of Court House square	730 ft.

WABASH.

Gas Well No. 2 Contractor Robinson's Record.

Drift	28 ft.
Niagara	425 ft.
Hudson and Utica	425 ft.
Trenton	54 ft.
Total depth	932 ft.

NORTH MANCHESTER.

Gas Well No. 1.

Drift	274 ft.
Niagara limestone and shale	300 ft.
Hudson River limestone and shale	250 ft.
Utica shale	306 ft.
Trenton	50 ft.
Total depth	1,180 ft.
Trenton below sea level	355 ft.
Altitude of surface	775 ft.

MINERAL WATER.

The test well bored for gas on the farm belonging to White's Manual Labor Institute yielded no gas, but developed an abundant flow of chalybeate water. The flow is delivered from a metal stand pipe, which is so arranged with a cap on the top as to cause the water to fall in a dome-shaped sheet of great beauty. No buildings have been erected in the vicinity of the well. The water probably has all the medicinal properties of springs containing iron. From the appearance of the sedimentary deposit seen around the well it is safe to say that the salt of iron dissolved in it is in a form to be easily assimilated by the system. The taste is not unpleasant, and it will be found very valuable in all diseases where iron is indicated.

BLOWING WELLS.

A well on the farm of Mr. John H. Pefley has barometric properties of a marked character. The well is sixty-two feet deep and is cased with nine-inch sewer tile pipe from the top to the bottom. In it has been placed an ordinary deep well pump, the base of which closes the top of the well. After the pump was put in position Mr. Pefley noticed that during unsettled weather the wind was either passing in or out of the well with great force. To render the force more apparent he had a large whistle made of two convex disks of tin with a hole in the center, like those boys get in prize packages of candy. This he attached to a short piece of gas pipe which had been screwed into the base plate of the pump. The device had the desired effect, and so intensified the sound of the air as it passed through the whistle as to cause it to be heard two miles distant; and it is a very frequent occurrence for it to be heard blowing at Dora, one-half mile away. The sound is most intense when the weather is stormy, or at a time when the mercury in the barometer is rapidly falling. At the time of our visit the indications were for fair weather, and the air was rushing into the well, but not in sufficient force to cause the whistle to sound. The flame of a candle or match when held near the opening in the base plate was strongly deflected, and the smoke rapidly carried into the well. On placing the ear over the opening a commotion could be heard very distinctly, as if the air was passing through the water at the bottom of the well, and there is no doubt but this was the case. Mr. Pefley says that when the disturbance is at its highest water and spray is thrown to the top of the well and the pump thrown into a violent tremor.

By reference to the section of this well given under Drift Details, it will be seen that the water comes from a stratum of sand lying between strata of impervious hard-pan clay. A reasonable explanation of the

phenomenon is the supposition that sand is saturated with water below and filled with air above, each occupying a place in the stratum determined by it specific gravity. In addition to the small air spaces there may be larger cavities. The theory is that these air spaces communicate with the well through the water, and that when the density, or pressure of the outside atmosphere is the same as that within the sand, there will be no current either way. This state of equilibrium corresponds with a stationary barometer. Increased density of the atmosphere on the outside, indicated by a rising barometer, would cause the air to pass into the well, through the water and into the sand, so as to equalize the pressure. On the other hand a falling barometer, with a corresponding decrease of density on the outside would disturb the equilibrium and reverse the flow. The well-known fact that the barometer rapidly changes with the changes in the density of the atmosphere in stormy weather explains the greater rush of air in or out of the well at such times.

DEEP WELL IN WABASH.

Several years ago a deep well was put down in the Court House Square. The bore started in the Niagara limestone and continued in limestone and shale to the depth of 2,270 feet without finding water that would flow from the mouth of the well. The first water was found at 85 feet. It is said that the water in the well rises and fall with the stage of the water in the river. In 1875 Dr. G. M. Levette carefully tested the temperature of the water, which rises within 85 feet of the surface, and found it uniformly 50½° F. at 100 feet, 500 feet, 1,000 feet and 2,270 feet down. The atmospheric temperature was 85° at the time the well was tested.*

ARCHÆOLOGY.

A few small mounds are said to exist in the southern part of the county. One mile west of Roann near the north bank of Eel River, on the farm of Mr. Silas E. Shoemaker, is an extensive burial place of the Miami Indians, and bones are frequently exposed in plowing the land. On the farm of Mr. R. G. Arnold in Pleasant Township, Sec. 12, Tp. 29, Range 5 East, there is a mound having an elevation of sixty feet above Silver Creek, which the Indians used as a burial place. The mound consists of gray gravel to the bed of the stream. Mr. Arnold says that in cultivating the burial place soon after it was cleared the plow turned out pipes, arrow-heads, peelers and parts of human bones, but they were carried away years ago by relic hunters. Notwithstanding relics are scarce some fine specimens have been picked up, and valuable collections made by Mr. Herman U. Blood, of Lafontaine, Mr. Thomas Pefley, of Dora, and Dr. M. E. Renner, of Lagro.

*Geological Survey of Indiana, 1875, pages 43 and 44.

ECONOMIC GEOLOGY.

Agriculture is the principal industry dependent upon the geology of the county. Its soil is adapted to all branches of farming, and the industry is so varied as to prevent a failure because of unfavorable season. If the wheat yield is short the proprietor is nearly sure of an abundant corn crop; if his swine die he will push the growth of his young cattle; if his apple orchard is barren he will make up the deficiency from his small fruit garden. Times may be hard, but with a Wabash County farm to fall back upon for money, he should be thankful and happy.

In the production of wheat and corn it ranks with twenty of the best counties in the State, and especially is the Eel River country noted for its big wheat crops. In the number of horses, cattle and swine grown, it takes rank as one of the fifteen leading counties. The care given to protecting the fertility of the soil and rotation of crops is shown by the number of acres sown to clover, in which it ranks as the fourth in the State.

In 1891 the land with improvements was appraised at $32.19 an acre, which is higher than that of any other county on the Wabash River.

The Quarry Interest of the county is still in its infancy. Many of the best quarries have been very slightly developed. Especially is this true of those on the Mississinewa River, which should have railroad facilities to make them valuable. The details already given show the extent of the beds and the quality of the stone.

At this time nearly all the quarrying is confined to the upper limestone strata. In the future more attention should be paid to the lower hydraulic beds. If this stone is selected it gives promise of great durability, and there is no handsomer stone anywhere for rough or foundation work. It will doubtless dress well under the hammer, and if it does it is hard to conceive of a prettier stone. In proof of its durability the doubting ones are referred to Mr. William Hazen, County Auditor, who has a door-step which came from the Treaty Creek beds, above Messrs. Small & Co.'s mill, that has been in use for forty years, a part of this time in front of the old court house, and is still a good door-step.

The Treaty Creek stone was used by Mr. James M. Furrow, in 1850, in building the piers and abutments of the Cincinnati, Wabash & Michigan Railroad bridge over the Wabash River. The abutments have stood the test fairly well with occasional repairs. The same stone was used in 1853 in building the Wabash Railway bridge over Charley Creek, but was not well selected, some of the stone crumbling so badly that the structure was replaced in 1889. The stone used in the locks of the Wabash and Erie Canal, in the vicinity of Lagro, came from equivalent beds on the west bank of the Salamonie River, and shows that the strata having a laminated structure, or too large a percentage of earthy matter, do

not weather well. The dark, blue stone of uniform internal texture is the portion of the formation most likely to stand the test in a wall. The New Holland stone seems to have the typical characters described.

Hydraulic Cement was manufactured on the south bank of the Salamonie River, one mile above the dam, in 1834, by David Watkins, who burned several kilns for use in building the locks of the Wabash and Erie Canal near Lagro. The old kiln is still standing in the mouth of a ravine opening to the river. The product of this kiln is to be seen in the old locks, and witnesses the good quality of the hydraulic rock of the Salamonie for the manufacture of cement. In 1840 a company was formed at Wabash for the manufacture of cement from the hydraulic limestone beds of Treaty Creek. Kilns were erected, machinery purchased and several hundred barrels of excellent cement made, but owing to the lack of shipping facilities they were unable to sell the product, and the enterprise was abandoned. Some of this cement was used in building the piers and abutments of the Wabash Railroad bridge over Charley Creek. It stood firm until 1889, when the bridge was taken down because some of the stone had gone to pieces; but the cement was unchanged and apparently good for several centuries of service.

The following analyses are taken from the Geological Survey of Indiana, 1873, pages 116–117: The analysis of the Wabash County cement stone, collected from a bed ten or twelve feet thick, on the Davis farm, near Somerset, has the following composition in one hundred parts of stone:

Moisture at 212° F.	1.000
Silicic acid	30.600
Alumina	16.720
Carbonate of lime	25.600
Carbonate of magnesia	12.713
Carbonate of iron	2.480
Organic matter, alkalies undetermined and loss	10.887
	100.000

Another sample from a seam five to ten feet thick, on Helm's Creek, two miles west of Wabash City, contains:

Moisture	2.000
Silicic acid	34.200
Carbonate of lime	28.000
Carbonate of magnesia	3.117
Carbonate of iron	1.242
Alumina	18.760
Loss and undetermined	12.681
	100.000

On Chapelle (Lagro) Creek, Lagro. The seam is ten and fifteen feet thick, and contains:

Moisture at 212° F.	1.80
Silicic acid	35.60
Alumina	17.86
Carbonate of lime	26.00
Carbonate of magnesia	2.42
Carbonate of iron	4.14
Loss and undetermined	12.18
	100.00

Judged by their composition, these stones should make a good hydraulic cement.

The thickness of the hydraulic strata, as given in the quotation by Prof. E. T. Cox, is much under that of many of the exposures seen by us in various parts of the county.

Nothing was done, after the Wabash Company quit business, to develop the cement industry until 1891, when the Lagro Cement and Manufacturing Company, Rev. J. D. Shultz, President; A. J. Abbott, Vice-President; M. Hogan, Treasurer, and J. W. Egnew, Secretary, was organized, and commenced work by erecting a calcining kiln. The company is composed of men of energy and intelligence, who have carefully experimented with the product of their kiln, and are producing a cement of splendid quality. They have put on the market a water lime which is not excelled by any natural cement; and they have specimens of artificial stone that are equal in strength to the best Portland stone. It seems not to be generally known, but it is a fact, that some of the American imitations of Portland stone have been found superior to the original when carefully tested by engineering experts, and there is good reason to expect that, with superior hydraulic stone in great abundance, extensive beds of marl, and other materials necessary to make an artificial stone readily available, the company will succeed in establishing a paying industry in other lines than the production of ordinary water lime.

Lime was formerly burned at Wabash from the picket rocks, and made a good "fat" lime of about the same quality as that made from equivalent beds at Delphi. The lower ledges of the quarrystone beds, where free from chert, will make an excellent quality of lime, but will not pay a profit while kilns more favorably located in the gas belt are supplied with cheap fuel.

Sand, for plastering and building purposes, is found abundantly in the river and creek bars and in the bluffs, where it has been deposited by the forces which have produced the modified Drift strata.

Clay for making brick and tile can usually be found wherever needed. Good drain tile is made by the Hubbard Brothers, in Liberty Township,

section 16, township 26, range 7 east; and by Mr. Cothanhour in Waltz Township, section 10, township 26, range 6 east, who has extensive works driven by steam. On section 36, township 29, range 5 east, in Pleasant Township, one mile east of Roann, an excellent clay is found that is used for the manufacture of brick. Good brick clay was seen in a number of places in Lagro Township.

Bog iron ore is not infrequently found just beneath the surface in draining swampy lands, but such ores at the present time have no commercial value, and it is not likely they will have any again soon.

In 1888 Wabash County had 884,714 rods of drain tile in operation, which was more than that of any other county in the State, and in the same year 164,969 rods were laid. This is a splendid record and speaks volumes in testimony of the thrift of its farming community. It seems to us that in many places long lines of tiling might be obviated by sinking dry wells down to the underlying porous gravel, where it has been found to occur in digging stock wells, and running the drains into it rather than to a long distance surface outlet.